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OF THE
ONTARIO ECONOMY

SEPTEMBER 1994

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ENVIRONMENTAL RESTRUCTURING OF THE ONTARIO ECONOMY

Report prepared by:

The ARA Consulting Group Inc.
Infometrica Ltd.

December, 1993

Report prepared for:
Ontario Ministry of Environment and Energy

ACKNOWLEDGEMENT AND DISCLAIMER

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Appendix 2 - Background on the Econometric Models and Simulations

EXECUTIVE SUMMARY

Background

The Ontario Ministry of the Environment asked the ARA Consulting Group Inc., in cooperation with Informetrica Ltd., to study the relationship between the environment and economic structure. Specifically, the Ministry wanted to know if environmental restructuring would have a significant impact on the state of the environment in the longer term.

Environmental restructuring was defined as an active process of altering economic structure towards the sustainable use of resources. Answering the question requires measuring two broad components - economic structure and environmental conditions. The consulting team proposed to use existing data and models of the province to measure the first and newly developed data on resource use and emissions to the environment for the second.

The objective of the study was to develope a series of forecast scenarios (from 1992 to 2010) for the province's economic structure that incorporated policy and other external changes. These economic results would then be linked to environmental measures. In this way we could estimate whether policy or other economic factors might change the structure of the economy so as to reduce environmental impacts. Of course, understanding the potential impacts of Ontario's policies on both structure and environmental indicators was a key objective of the analysis.

Methodology

The first step in the study was to organize data representing economic structure and environmental indicators. Statistics for the first are extensive and have been widely studied while the second type of data has only been developed recently and is often incomplete. These two areas are summarized in order below.

- *Economic Statistics and Models*

  Structural change in the economy is defined in the study by traditional Statistics Canada measures of output, employment, income, prices, taxes, investment, capital stocks, trade flows and other concepts. These standard measures of the economy are combined in econometric models of the national and provincial economies maintained by Informetrica. These models are the basis for regular long term forecasts. An Informetrica Base Case forecast from 1991 was used as the starting point for the analysis and the four alternative scenarios were built as variations on this theme.

Relying on this type of data and model has both advantages and disadvantages. Positive aspects include the ready availability of long term forecasts that are widely used in other policy and business applications. The models are also easily manipulated to simulate various changes in policy and other external conditions. There are, however, disadvantages for this type of study. In particular, the models are not easily changed to incorporate new kinds of economic decisions or technological change that might impose the environmental restructuring that we seek to study. Essentially the models and data are heavily influenced by past conditions and behaviour that the environmental restructuring wishes to change.

These statistics and models -- as well as conventional wisdom -- isolate five sources of structural change in the economy:

- Demographics;
- Technological Change and Resource Endowments;
- Environmental Regulations and Preferences;
- Increasing International Trade and Investment; and
- Domestic Investment/Savings Patterns.

These five factors shift the distribution of output and employment among economic sectors. **Economic structure is defined, for purposes of this study, as the distribution of Gross Domestic Product (in 1986$) among the province's industries.**

- *Environmental Indicators*

The second class of measures for the study are based on resource use and waste emissions data for Ontario. This data is available for a few years beginning in the mid to late 1980s. Volume measures of resource use (e.g. board feet of wood cut, electricity generated) and waste emissions (e.g. tons of solid waste to land fill, gas emissions to air) are usually related to source industries or population groups.

Environmental indicators are created by dividing the use and emissions measures by GDP or population data to give a base value -- usually in 1985, 1986 or 1987. Since the GDP and population values are included in the economic forecasts the indicators become the starting point for estimating use and emissions in the future. If we assume that the indicators are constant through time we can multiply each by the forecasted value of industrial production or population and derive future, estimated levels of resource use of waste generation.

There are several disadvantages in calculating environmental effect in this manner. First, these measures reflect existing technology in the use of resources and generation of waste. The measures are limited to just one or two years and thus do not reflect changes through time. It is impossible to measure the expected changes in these technologies in the future but these changes may be the most important source of reduced environmental impacts. In general, this means that we must assume no change in resource use and waste generation technology in the simulations.

A second disadvantage of these measures is that they are limited to "end of pipe" effects and reveal nothing of the wider, ambient effects of waste and resource use.

The economic and environmental measures described above were used to create twenty five indicators and link them to the Informetrica base case forecast. Alternative simulations of the resulting system were the basic methodology for testing the impacts of environmental restructuring.

Results

Historical data collected for the study reveal interesting patterns from Ontario's past. In particular the major economic restructuring of the 1970s and 1980s was the shift of employment and output away from primary and manufacturing industries to the services sectors. This change was not uniform among sectors or in terms of employment and output. Business cycles are particularly severe in the primary and some manufacturing sectors and the recession of the early 1990s reduced employment in these sectors. Productivity gains in some industries reduced employment growth while output increased and this pattern also shifted industrial structure.

Historical evidence for the environmental indicators reveals a distinct industrial pattern of waste and resource use. Primary and basic manufacturing sectors are heavy energy users and create large volumes of emissions to water and air. Service sectors generate more solid waste going to land fill. Across all of these patterns, Ontario is seen as fairly typical of other industrial jurisdictions as measured by OECD studies.

Five forecasts of the provincial economy were developed to extend these historical patterns into the future. These are summarized in Exhibit A in terms of the basic underlying assumptions -- demographics, international growth, domestic policy and immigration. In general each scenario builds on the preceding one with growth increasing. Scenarios three and four are somewhat special cases and are discussed in more detail below.

<table>
<tr><th colspan="3">THE FIVE PROJECTIONS</th></tr>
<tr><th>Name</th><th colspan="2">Description</th></tr>
<tr><td rowspan="3">Base Case</td><td colspan="2">Population growth slightly below 1976 to 1991. International growth is weaker than in the past because of high real interest rates. U.S. growth is restrained by high taxes. Canadian growth is skewed in the first ten years by recovery from the recession. Manufacturing expands relatively quickly.</td></tr>
<tr><td></td><td><i>Compound Annual Growth
1992 - 2010</i></td></tr>
<tr><td><i>National Population
U.S. G.D.P.
Canadian G.D.P.
Ontario G.D.P.
Ontario Employment</i></td><td>1.0
2.7
2.7
3.0
1.4</td></tr>
<tr><td rowspan="3">Scenario 1
International Growth</td><td colspan="2">Built by adding to the Base Case. By 2010 the European and U.S. economies are 20% larger than in the Base Case. This creates higher demands for Ontario exports. Immigration into Ontario adds to labour supply and prevents shortages. Increased government revenues are used to reduce the deficit. Production technologies are not changed.</td></tr>
<tr><td></td><td><i>Compound Annual Growth
1992 - 2010</i></td></tr>
<tr><td><i>Ontario G.D.P.
Ontario Employment</i></td><td>3.6
2.0</td></tr>
</table>

<table>
<tr><th colspan="3">THE FIVE PROJECTIONS</th></tr>
<tr><th>Name</th><th colspan="2">Description</th></tr>
<tr><td rowspan="3">Scenario 2
Labour Productivity</td><td colspan="2">Built by adding to Scenario 1. Government uses the new revenues related to increased growth to improve education and build infrastructure. Private firms invest in new machinery and equipment. Labour productivity improves and real incomes rise. Much of the new wealth is transferred to foreign creditors. Higher productivity reduces labour requirements. Production technologies are not changed.</td></tr>
<tr><td></td><td><i>Compound Annual Growth
1992 - 2010</i></td></tr>
<tr><td><i>Ontario G.D.P.
Ontario Employment</i></td><td>3.8
1.8</td></tr>
<tr><td rowspan="3">Scenario 3
Environmental Initiatives</td><td colspan="2">Built on Scenario 2. Environmental initiatives total 80 billion nationally and 30 billion (1991$) in Ontario. Spending flows to environmental protection industries. Some assumed shift in consumer spending and industrial production patterns.</td></tr>
<tr><td></td><td><i>Compound Annual Growth
1992 - 2010</i></td></tr>
<tr><td><i>Ontario G.D.P.
Ontario Employment</i></td><td>3.8
1.8</td></tr>
<tr><td>Scenario 4
Industrial Shift Case</td><td colspan="2">Built on the Base Case. Industry shares are altered to simulate the effects of extended reductions in relative shares for raw material and primary industries while service industries continue to expand. Patterns of industrial shift are determined by historical trends from 1976 to 1990.</td></tr>
</table>

The first four cases have important aspects in common. Each represents a relatively small variation around the Base Case. By the year 2010 in the Base Case the Ontario economy is approximately 100% larger than in 1992 in terms of output and real incomes. In a pattern that includes the recovery of the manufacturing sector from the 1990-1992 recession, the service sector expands along with certain manufacturing activities. Significantly different external forces (e.g. higher international growth in Scenario 1) manage to shift the overall size of the economy by no more than 15% of the projected Base Case values in 2010. This suggests that fundamental forces will expand the economy within these broad boundaries whatever the external forces. The shift in industry composition among these scenarios is even less. Market forces and trade patterns included in the model (and reflecting the normal patterns of economic adjustment from the 1960s to the 1980s) limit the extent of economic restructuring.

The final industrial shift case was a direct response to the structural inertia in the first four projections. In this case we abandoned the econometric models and imposed a series of structural shifts that altered the distribution of industrial output between 1992 and 2010 by at least as much as between 1970 and 1990. This final case assured that we could measure the environmental impacts of a significant structural change.

The "environmental initiatives" scenario takes a slightly different approach. The other four cases assume that technological change is the same both among scenarios and across time. This assumption is consistent with the statistical limitations of the environmental indicators. In this case, this assumption is relaxed by simulating the effects of investing $33 billion in environmental protection in the 1990s in Ontario.

Impacts of these investments are reflected in (assumed) lower values for some indicators as new regulations and technologies reduce the amount of waste or resource use per unit of output. New activity is stimulated in environmental protection sectors and reduced in industries that are faced with required reductions in emissions.

The five scenarios suggest that environmental restructuring in Ontario would have relatively small effects on the Provincial economy. By the year 2010, most indicators show modest changes as a consequence of the shifting industrial composition in Ontario. Variations in indicators among first three scenarios are minimal because structural inertia incorporated in the model dampens major shifts in production among industries. Variations in indicators for the "environmental initiatives" scenario are significant but are driven by the assumed and targeted change in industrial production techniques that are a consequence of investments and regulations aimed at lower resource use and emissions.

Variations in the "industrial shift" scenario reveal a notable reduction in contaminant releases to air and water as well as lower resource use. Increased levels of service activity are also associated with more solid-wastes going to landfills.

Conclusions and Future Research

Model simulations and the historical analysis suggest that structural change in the economy is most affected by changing technology with other factors (e.g. international trade and investment and demographics) less important. These conclusions suggest that provincial industrial polices aimed at altering industrial structure to reduce environmental damage will have a limited impact.

Industrial structure, at least as measured by traditional economic methods, is slow to change in the face of new polices or altered international conditions. This inertia is related to market forces and international trade patterns.

This does not mean that government policies have no impact on the extent on environmental change. For example, broad monetary and fiscal policies that affect the overall growth of the economy will slow or accelerate all forms of economic activity, affecting the extent of resource use and waste generation. Environmental considerations certainly reinforce other policies that might act to slow the overall rate of growth.

Scenario 3 pointed out an important conflict between industrial policies -- driven by international competition -- and environmental initiatives. Major efforts of the latter type, as illustrated in Scenario 3, could increase operating costs of enterprises in Ontario in the short run. Such cost increases could be problematic to some industries if the environmental initiatives are taken unilaterally in the face of expanding trade liberalization. These results indicate that environmental initiatives and international trade agreements should be coordinated where possible or that environmental policies may have to be adjusted temporarily so as to offset international trade developments.

Scenario 3 also suggested that there are limited opportunities for building a domestic environmental protection industry in response to provincial initiatives. In the face of a significant (but not enormous) investment in new environmental protection facilities, few industrial suppliers were assumed to expand in a manner that would exhaust existing capacity. Creating a long term incentive for Ontario businesses to produce environmental protection goods and services on a large scale (i.e. to shift the industrial structure) would require extended and extensive access to foreign markets.

Most of the major industrial shifts that are noted in the study are due to technological change. This is particularly true in the "environmental shift" case where significant reductions in emissions and waste are tied to new regulations and investments that alter the manner in which industry uses the environment.

Where industrial restructuring follows its "normal" course into the next century, there are important shifts in the composition of environmental impacts. Reduced emissions to air and water are replaced by increase solid waste from services. While such a shift is desirable, it reduces environmental problems that are international or national in scope and shifts cost and policy concerns to the more provincial and local area of solid waste disposal.

Future research into the question of environmental restructuring should focus on the impact of changing technology in industrial processes.

1.0 INTRODUCTION

The Ontario economy is struggling out of the worst recession in its recorded history. Job losses and plant closures have swept across many sectors and left considerable economic damage behind. It is generally acknowledged that the recession is only a part of the problem. International competition, new technology, changing demographics and other structural forces are also challenging Ontario businesses[1]. Government policy is part of this process of change; sometimes reacting to external factors and sometimes imposing new conditions.

Complex interrelations among policy, the recession and external structural changes are affecting various industries. In an attempt to understand and manage these changes the Ontario government is building a new industrial strategy. Environmental considerations are a central part of all this change[2]. This study examines relationship between the environment and economic structure.

In particular the study looks at environmental restructuring which can be defined as: "...shifting economic development towards the sustainable use of resources". Seen in this way the restructuring of the economy could either create environmental improvement or deterioration. Improvements would involve either absolute or relative declines in the role of resource-using or waste-generating activities and an associated reduction in the use of scarce or polluting resources. Environmental deterioration would involve the opposite effects.

This study of environmental restructuring is meant to answer the questions: To what extent is Ontario's economy dependent on non-sustainable resource use? Will the structural changes that impact the provincial economy over the next twenty years increase or reduce environmental damage and resource use? There is an important variation on this question; Can government policies create specific types of industrial restructuring that will reduce environmental damage and promote sustainable development?

---

[1] For example, see Michael Porter's 1991 report to the Business Council on National Issues which discusses the impact of these factors on Canada's competitiveness. See "Canada at the Crossroads: The Reality of a New Competitive Environment" A study for the Business Council on National Issues, October, 1991.

[2] See "An Industrial Policy Framework for Ontario," Ministry of Industry Trade and Technology, July, 1992.

These are difficult questions, filled with complex concepts (structural change) and measurement challenges (environmental damage). Our report seeks to move as close as possible to answers to these questions given the current state of economic and environmental data. The main objective is to draw useful policy implications out of the current information on structural change and environmental indicators.

Several factors limit the scope of this work and the extent of possible policy conclusions. For example, environmental data is largely limited to "end of pipe" type measures that estimate the use of resources as inputs and the extent of waste and emissions as outputs. Beyond this, we lack information on the broader-based impacts of pollution on the health and welfare of the population. Even more fundamentally, the economic statistics and models that exist for Ontario rely on a traditional view of economic structure. New social values or consumer preferences for new products are not adequately captured with this data.

Limits on the effectiveness of provincial policies to guide economic restructuring are another example. Technology, demographics and international economic conditions all impact economic structure and are usually beyond provincial control.

These limitations are only a partial deterrent. With or without data and effective policies the government must deal with serious challenges and decisions must be made. This study will describe data, policy and other information limitations and provide practical suggestions for future research.

There are two broad areas of emphasis in this work. The first is structural change in the economy and the second is measuring environmental indicators. These two areas are investigated separately in the report and then combined to derive policy implications. This introduction is followed by a discussion of structural change in modern economies. The third chapter covers a Base Case and four alternative scenarios of structural change in Ontario between 1992 and 2010. A fourth chapter describes the creation of environmental indicators for the province. These indicators are combined with the economic scenarios in chapter 5 to provide measures of the environmental consequences of structural change. Policy implications of the findings are discussed in Chapter 6 and conclusions and recommendations for future research are described in the last section.

Research for this report involved collecting and reviewing existing data and models that describe the state of economic structure in Ontario. The emphasis is on using existing information, describing its limitations and providing guidance for immediate policy consideration. There is ongoing research that will provide much more detailed impacts in the future[3]. This report is based on preliminary environmental data and on the application of a traditional econometric model of the Ontario economy. The latter tool is the basic source of information on structural change.

ARA Consulting, the primary contractor for this work, teamed up with Informetrica Ltd and the latter provided the econometric model. The Informetrica model of the Ontario economy is a detailed source of industrial data and projections for the province. The model is based on statistics for capital, employment, Gross Domestic Product (GDP) and investment for one hundred industries and industry groups. Industry activity is determined by demand, supply, price, trade and other factors generated by a national econometric model. Provincial activity is determined by allocating national industry forecasts based on either historical or projected provincial shares.

The nature of the linkages in the national and provincial models are described in Appendix 2. These linkages are important because they allow for price based changes in industrial and consumer behaviour and trade related shifts in industrial supply and demand.

Environmental concerns are reflected in our work through a series of indicators. Each indicator is a measure of emissions or resource use (e.g. CO_2 emissions) divided by measures of economic activity (e.g. GDP in the Ontario trucking industry). These indicators are generally only available for one or two years in the late 1980s. They combine information about production technology (e.g. output per unit of material, labour, energy or capital input) and environmental impacts (e.g. waste generated per unit of output).

A major concern in this work is that we are unable to discover how new technology (either in production or waste/emission control) has changed the indicators in the past or will change them in the future. Without this technological information we are restricted in how we can measure environmental impacts. We assume that technology is unchanging between 1991 and 2010, except under specific conditions where current policies and known technology combine to achieve existing goals. Extensive research is underway on the cost and effectiveness of various technologies in reducing resource use or waste/emission generation. Our job is to review the policy issues that span all the gains that might be available from these changes and to look into the impact of economic change other than these technological effects.

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[3] See the work currently underway for the Ministry of the Environment by VHB Research and Econometric Research Limited. This study will gather more detailed indicators (by region, industry and by resource/emission) and apply them to a very desegregated provincial input-output table.

Working with these data, tools and objectives, the study investigates the effects of economic restructuring on resource use and emissions to the environment. International changes, demographics effects and government policies are all tested as sources of restructuring and environmental change. In a limited way shifts in technology related to environmental effects are also tested. The evidence shows that provincial government policies are not likely to be able to affect major shifts in economic structure and associated environmental effects. New technologies are the most powerful lever affecting economic structure and environmental impacts.

2.0 THE ECONOMIC STRUCTURE OF ONTARIO

This study is concerned with forces that determine Ontario's economic structure. Structure refers to the mix of people, resources, products, processes, regulations, markets and ownership in Ontario. This section provides an introductory review of Ontario's economic structure and its evolution over the last twenty years. For purposes of this study the structure of the economy is defined by industrial composition: the distribution of employment, output, investment and other measures among the province's industries.[4] We distinguish five major elements that impact structure.

Once the basics of economic structure are covered the study moves to the links between structural change and environmental effects.

2.1 Economic and Environmental Restructuring

The relationship between economic and environmental structure is discussed here and explained in terms of the five fundamental factors driving change.

2.1.1 Economic Restructuring - Industrial Composition

Five elements drive structural change:

- demographics;
- international conditions;
- domestic policy;
- resources/technology; and
- savings/investment.

These all combine to create a shifting configuration of industries in the local economy. It has become common practice to regard industrial composition as a basic measure of economic structure. For example, the Ontario government chose to use the industrial composition of employment to describe structural change in recent series of papers on industrial policy.[5] Certainly the distribution of industries is a useful picture of how the people and resources of the economy are employed.

---

[4] Many alternative definitions of structure are possible, but the use of industrial composition fits best with the overall purpose of this report and with the input-output and econometric models that are used in the analysis.

Some care must be taken with this interpretation of structure because the definition of industries is a moving target. Changes in technology, products and processes all combine to make the concept of an industry elusive. For example, in 1960 there was no computer software industry. Most countries update their standard industrial classifications regularly (perhaps every ten years). This study is covers forty years of Ontario's economic development: twenty years of history and forecast. This span is more than long enough for new industries to be created and old one's to die so that this matter of industry definition must be kept in mind.

There are several different measures that could be used to represent industrial composition including employment, capital (assets), sales, value added (GDP), profits and investment. Each would give different image and interpretation of structure. **In this study economic structure is defined as the percent distribution of output (measured by real Gross Domestic Product) among industries in the economy. Structural change or restructuring is defined as change in the industrial composition.**

2.1.2 Environmental Restructuring

The environment itself is a basic element in economic structure. Natural endowments that have been so long taken for granted are now seen as the ultimate source of wealth. The notion that economic forces could be used to exploit the environment without any permanent feedback has been challenged by evidence of permanent environmental damage related to intensive economic exploitation over the last twenty years.

Interest in the linkages between the environment and the growth potential of the economy are not new. Early theoretical work by Georgescu-Roegen (1971) and others pointed to the limited potential of the environment to support industrial expansion. Interest in this type of work expanded in the 1970s with the release of the Club of Rome study on "Limits to Growth" and then dramatic events of the energy crisis. In the 1980s concern over energy waste spread into a broader concern over the widespread abuse of the environment.

---

[5] Several recent Ontario publications have emphasized the goal of higher value added for provincial industries. The most recent contribution, "An Industrial Policy Framework for Ontario" from the Ministry of Industry, Trade and Technology (MITT), defines value added in exactly the same manner that Gross Domestic Product in this report. See also Budget Paper E in the 1991 Ontario Budget, p. 89.

The United Nations study "Our Common Future" by the Brundtland Commission, promoted the concept of sustainable development as a guide to the future management of the environment. This idea proposes a fundamental change in the organization of the economy. It advocates new policies and new accounting methods to reflect the long term importance of environmental assets in economic decision making.

Herman Daly and John Cobb have extended theoretical and empirical work in this area by proposing an entirely new vision of economic decision making. Their concepts transcend the traditional economic theory of market-based decisions and limited government intervention. They see community-based economic systems that respond to social preferences and reflect the long term value of the natural environment.[6]

Daly and Cobb propose a measure of overall economic welfare to replace Gross National Product. Their measure, the Index of Sustainable Economic Welfare, begins with the conventional measure of household consumption and then adjusts for income distribution effects, air, noise and water pollution and depletion of natural resources. This measure is interpreted as an experimental indicator of sustainable development.

The scope of economic change and measurement techniques proposed by these ideas is beyond the capability of the econometric models used in this report. Our work seeks to go beyond the limits of the models and includes separate measures of many of the environmental effects that Daly proposes.

It may be that, as Daly suggests, we are in the early stages of a new type of economic paradigm that will replace market rules of supply and demand (where supply was not constrained by natural endowments) with natural rules of distribution that preserve and protect the environment for future generations. Such a change would likely impose a major shift in economic structure and the associated industrial composition.

---

[6] See "For the Common Good: Redirecting the Economy Toward Community, the Environment and a Sustainable Future" by Herman E. Daly and John B. Cobb, Jr., Beacon Press, Boston, Mass. (1989).

Such a shift would imply more than simply changing the mechanism for economic transactions. It would also include a fundamental shift in power from individuals to group-based values. If decisions are not group-based they would, at a minimum, require a change in individual values. In either event, the institutional change that we are contemplating here would take more than twenty years.

In this study we will address these matters from two perspectives. First, we will ask how economic structure impacts the environment. Could changes in structure alter the extent of environmental impacts over twenty years? Are existing trends in industrial composition sufficient to reduce waste or resource consumption? Second, we will ask whether environmental demands (and a new economic paradigm) could impose a shift in economic structure that would reduce environmental impacts.

At the core of these questions is the important of the link between technological change and economic structure. Predicting the extent of technological change in the future is well beyond the scope of this project. This leaves a fundamental frustration as the study cannot answer the biggest question of all: Is there a feasible combination of technologies and economic rules that would allow a clearly sustainable path for economic development?

Accepting these limitations we now proceed to study economic structure and environment indicators for Ontario over twenty years of history (1971 to 1990) and the future (1991 to 2010).

2.2 Elements of Structural Change

This section introduces five major elements that can have a long term impact on the structure of the provincial economy. Of these, demographics and international forces operate independently from provincial circumstances. Three others (domestic government policy, technology/productivity and investment/savings flows) are partly related to the long term changes in the economy. These five factors all combine to create a gradual shift over time in the industrial composition of the economy.

These five factors were selected in consultation with the Ministry. Long term economic analysis and forecasting has traditionally focused on demographics, international conditions and policy as key exogenous factors. Economic models, including the Informetrica Model that is used here, are designed with demographic sectors, links to economic activity in other countries and policy levers that can be manipulated to simulate these factors.[7]

With the growing importance of international investment and commerce, economic structure is increasingly related to the growth of export industries and the impact of import competition. Trade theories consider factors such as resource endowments, technology, productivity and savings/investment flows as the major determinants of trade patterns. Recent research by Porter and Reich have heavily influenced Canadian (and Ontario's) industrial policy and their views can be included through our five factors. The next section of the report describes how these ideas on economic structure are linked to our work.

2.2.1 Demographics

The population is the stable foundation of the economic structure: the people who create the demands and supply the goods, services and capital. Birth and death rates combine with immigration to determine the composition and growth of the population. These changes are small relative to the overall size of the population and they create minimal annual changes to size and age distribution.

Thus, demographics are an important long-term stabilizing influence on the economy because only 0.2% of the total population is altered by birth, death or immigration in a given year. For example, in 1991 there were only 146,000 births and 72,000 deaths and net immigration of about 100,000 among Ontario's 9.9 million people. There is a tendency for these change factors (births, deaths and immigration) to change slowly, adding to the inertia or stability in population changes.

The relative stability in Ontario's population is reflected in the range of forecasts prepared by the provincial government.[8] Starting with the 1991 population (9.9 million people), the projections show little annual variability in births (between a low of 136,000 and a high or 152,000), deaths (between a low of 102,300 and a high of 105,400) and net immigration

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[7] See Appendix 2 for a description of the structure of the Informetrica Models for Canada and Ontario. The design of the models is very similar to most econometric models that rely on time series of national and provincial economic statistics. Informetrica's system is well suited to our work because it focuses on annual, detailed data for industries and is used primarily for long term projections.

[8] See "Ontario Population Projections to 2015", Ministry of Treasury and Economics, June 1991.

(varying between 89,500 and 149,500). These forecasts result in small variations in the final population projected for 2010; between a low of 12.321 and a high of 12.596 million. There is a difference of just 0.25% in the implied compound annual growth rates (from a high of 1.43% to a low of 1.18%).

The stability of demographic projections implies a high level of confidence in the expected population for the year 2010. If environmental impacts were based solely on this variation in activity there would be little variation in environmental conditions in the year 2010. In fact, the various scenarios presented later assume a wider variability in population and associated economic and environmental conditions.

While the growth and composition of the population might change slowly, the shifting habits and preferences of key groups in the population can shift notably in as short a period as ten years and have a significant impact. For example, current demographic factors are causing a dramatic increase in the over 65 population and this is increasing the demand for health services, drugs and medicines and related goods and services. Various changes in demand due to demographics are reflected in the Base Case forecast described in Chapter 3.

2.2.2 International Conditions

The second fundamental factor driving structural change is international economic conditions. Ontario is tightly integrated into the Canadian and North American economy. As a general rule, smaller economies are more dependent on the activity of surrounding areas. Links to the rest of the world are relatively important as the smaller unit is more specialized and less self-sufficient.

In addition to this, there has been a well documented shift in all economies to more international trade and greater specialization.[9] Thus, even the largest independent economies like the United States are becoming more integrated into the world economy.

It is not just the growth of trade in goods and services that is driving this internationalization of business. Immigration flows and capital/investment movements are also increasing. These flows complement the trade process and equalize the pace and composition of economic activity across jurisdictions. Thus, excess demand for labour, capital or goods and services in one country or jurisdiction will lead to immigration, foreign lending or imports.

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[9] There are many current studies that focus on this "internationalization" or "globalization" of economic activity. The MITT industrial strategy paper and earlier provincial papers refer extensively to this factor. One of the more creative and insightful works on internationalization is by Reich (1990).

Because of increasing integration, economic change that is imposed or imported from outside jurisdictions will be a more important factor for smaller and more distinct jurisdictions. In some cases market conditions and policies in the larger and more homogeneous economies will impose industrial patterns on smaller and closer jurisdictions. This trend is more important as trade, investment and immigration policies are liberalized.

As government's turn to trade and investment liberalization, they encourage increased specialization of domestic industries. This process of specialization is driven by the trade patterns, investment decisions of businesses and the emerging patterns of consumer preference. Local government policies are less able to influence these changes. With free trade government's give up autonomy over industrial structure in return for the economic gains related to improved efficiency. In this environment, guiding economic structure becomes a matter of enhancing domestic factors such as labour quality, infrastructure and resources.

This freedom of movement across boundaries is, in turn, a consequence of both new technologies and government policies. The major contributing technologies include telecommunications improvements that reduce costs and improve service. Transportation technologies have also improved. Government policies that have removed various barriers, principally tariffs in the 1960s and 1970s, are equally important contributions to lower trade costs. Global initiatives such as the Canada-U.S. Free Trade Agreement (FTA), the General Agreement on Trade and Tariffs (GATT) and regional agreements such as the European Community have permitted the integration of huge markets.

There is no guarantee that these trends to global integration will continue. Problems with the Uruguay GATT round and with European integration are potential new barriers. But there are several technological and institutional forces that seem likely to push global integration forward. Perhaps the most important of these is the growing role of multinational corporations.[10] While trade negotiations may be delayed it seems likely that the integration of international capital markets will continue. Canada and other countries are also reducing immigration barriers to cope with growing population and political pressures.

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[10] See Reich, 1990 for a description of the role of multinationals in government policy and economic structure.

There is also reason to believe that globalization continues even when governments create barriers. Illegal migration, smuggling, more complex financial systems, piracy of intellectual property and other systems are continuously reducing international barriers.

2.2.3 Domestic Government Policy

While the process of global integration discussed above tends to restrict the autonomy of national governments, they retain considerable power and can affect the structure of the economy. There are many examples of domestic policies that shape economic structure over the longer term.

Broadly based fiscal policies determine the overall role of government by allocating incomes via taxes to public spending. The division of these powers among levels of governments determines the geographic distribution of bureaucracies and related industries. Industrial preferences are often imposed by fiscal choices. For example, the defence industry is largely supported through government priorities. Extensive subsidy systems support agriculture and other sectors. An overall increase in the role of governments through higher taxes and spending was a major structural trend from the 1950s to the 1980s. During the 1980s many governments moved towards limiting this trend but the evidence on the success of these restrictions is mixed.

The ability of government's in North America to influence economic structure through spending patterns in the next several years will be limited by current deficits. The very large excesses of spending over tax revenue will restrict government spending by national and provincial, state and local governments. Governments always have the option of shifting spending priorities and given the size of current spending such shifts would have important structural implications. For example, relocating government departments would impact the geographical distribution of economic activity. There are limits to even this type of fiscal change, however, because a major portion of government spending is fixed by legislation or legal commitments.

These fiscal issues and constraints are well captured within the framework of the econometric models and projections. In Chapter 3, we will be able to alter the flows of revenues and patterns of government spending and simulate the impacts on economic structure.

This means that major structural changes like the growth of the defense industry in the U.S. in the 1980's and the growth in educational facilities over all North America in the 1950 and 1960s will not be repeated unless economic growth accelerates, generating new revenues for government. Alternative views of the future, described in the next chapter, consider how a modest renewal of government spending might contribute to the next round of structural change.

Regulatory policies are only slightly less direct in influencing industrial structure. Energy policy, for example, has been used extensively in Canada to promote or sustain related industries such as the metal refining in Quebec and petrochemicals in Ontario.[11] More recently the trend to deregulation has shifted the mix of industries. Trade policies have restricted the growth in certain manufacturing industries (e.g. food processing) while encouraging the expansion of others (e.g. auto assembly). Transportation deregulation has forced some contraction in the trucking industry but it has reduced costs to Canadian shippers.

Essentially policies that don't cost money could still be used to influence economic structure. This is more likely to be the case if the popularity of deregulation is reversed in the next twenty years. Our study focuses on one particular case of extensive new environmental regulations as a source of new economic structure. Other regulatory choices are also possible and these are considered in Chapter 3.

2.2.4 Resource Endowments, Specialization and Technology

There are various theories that seek to explain patterns of international trade and the associated composition of industrial production. A traditional view of industrial specialization is based on resource endowments. For example, an economy with a relative abundance of arable land will develop extensive farming and food-related industries. A second theory of specialization focuses more on technology and competitiveness. In this view countries initiate and then exploit unique technologies. In fact, these two views are both relevant. The resource endowment perspective clearly applies to Ontario and explains the importance of wood, paper, metal ores and concentrates and electricity production as part of an export-oriented resource sector. Trade in more advanced manufactured products (electronics and auto assembly) is less related to resource endowments and more tied to available technologies and competitive conditions.[12]

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[11] The Quebec government, working with Hydro Quebec has offered major discounts on electricity rates to encourage the establishment of metal smelting and refining activities in the Province. Similarly, Canada's energy policy before 1985 encouraged the development of a petrochemical complex in Sarnia by limiting the price of Alberta oil and gas shipped east through pipelines that terminate in southern Ontario.

[12] See Daly (1988), p. 254-256, for an explanation of traditional (Ricardian) and modern (Heckscher, Ohlin, Samuelson) trade theories. Daly argues that the modern theory, with its emphasis on resource endowments, explains the smaller, traditional component of Canadian trade. The old Ricardian theory

Ontario has developed two economies - a resource based one, mostly in the north, reliant on endowments of forests, minerals and arable land and at the same time in the south, the manufacturing and service sector has developed primarily around the auto industry. The resource economy is increasingly independent of the secondary and service sectors. Expansion and contraction in the resource regions depends on global markets and prices as well as supply conditions. For example, the discovery of gold at Hemlo created an important structural change in the resources economy in twenty years. The proportion of Ontario's mineral production devoted to gold increased significantly during the 1980's shifting resources from other industries and communities. Weak markets for uranium and diminished supplies of iron ore are the opposite side of this coin.

The rest of the economy (and by far the largest part) is driven by the demand and supply of advanced products.[13] Demand is largely a matter of global, or at least North American, markets. Supply is determined by a combination of technology, investment, government policy, business and labour quality. While primary industries are controlled by external factors, efforts to change the mix of industrial activity for advanced products are less likely to be frustrated by international market conditions. Businesses and governments are constantly searching for opportunities with new products, processes or markets. Experience in Europe and Japan (and to a limited extent in Canada) shows that major advantages can be found by joint, long term government-business cooperation in developing new industrial opportunities. Over a long period this strategy can actually shape the structure of the economy. There is an ongoing debate in the area of industrial policy that concerns the long run potential for governments and businesses to create lasting competitive advantages in the production of advanced goods and services. A free market oriented view would argues that such efforts cannot succeed in the long run while an industrial policy viewpoint argues that Japanese and European success is due to deliberately managed competitive advantage.[14]

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emphasizes differences in technology, management and productivity and this view seems well adapted to explain growing trade and specialization in manufactured goods. Current government policies and commentaries in North American economic performance also emphasize technology and productivity.

[13] The main source of employment and income in the manufacturing sector is in the production of fabricated (e.g. metal stamping and finishing), processed (e.g. food processing and plastics moulding) and assembled (motor vehicle and appliance assembly) products. Many more jobs are created here than in extracting and refining primary materials.

[14] See Daly (1988) section 19-4 for a description of Japan's performance in trade in manufactured goods.

Global resource conditions and technology sometimes interact to create significant structural change. For example, in the 1970s the price of oil was driven up by a combination of supply restraint imposed by OPEC and strong industrial demand. These primary market forces eventually caused significant global, structural change. All through the 1970s and 1980s technological innovations and associated products and services designed to conserve energy found commercial success.

The data and models used in this report reflect the role of resource endowment, technology and trade in determining economic structure. Resource production and trade is captured through the historical patterns of trade and production costs. Technology is reflected mostly through the combination of capital and labour in production processes. The model projects improved labour productivity and trade performance related to new investments and new capital assisting in the production process. These factors act to shape the trade flows, employment levels and production activity in the forecasts.

Data and models are based on historical experience and are not able to predict all the dynamic elements of economic change. For example, it is difficult to incorporate the impact of new management techniques, new discoveries of resources or technologies. These latter changes are almost impossible to anticipate but are likely to have the most profound impact on economic structure. In the remainder of the report we will take account of the potential weaknesses of relying on these models and data and add descriptive or qualitative details to the scenarios.

2.2.5 Investment and Savings

Market-driven economies allocate resources over the longer term by directing savings into investments in new industries and products. The rate and direction of structural change will be determined by the balance of savings and investment and the social preferences over allocation. A rule of economic growth theory is that higher savings/investment rates are associated with higher growth.[15]

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[15] There are various ways that the link between savings and long run growth has been studied. As a general empirical observation, the modern economies with high savings rates have achieved steady growth and high rates of productivity improvement (e.g. Japan and Germany in the 1970s and 1980s). These general results fit the theory of economic growth that suggested higher savings would be associated with high growth. See, for example "Growth Theory: an Exposition" R.M. Solow, Oxford University Press 1970.

Government fiscal policy, mentioned above, is one route by which these savings, investment flows impact economic structure. Equally important is the process by which businesses save and invest in new structures and equipment. These choices will determine the distribution of employment, productivity and production in the future. The data and model used to build our base case and alterative scenarios in the next chapter include extensive details for these investment and capital decisions. Thus we are able to track or specify the investment-capital-employment-production linkages for the forecast period. These choices are made internally to the model (endogenously) based on growth, profitability and other factors. In some cases we will to override these "market-based" choices with new patterns of investment dictated by government or other factors.

For instance, consumers were assumed to show restraint in the purchase of new motor vehicles and businesses were assumed to spend more on environmental initiatives. These changes to the "market-based" part of the projections are largely contained in Scenario 3. This is discussed in more detail in the Chapter 3.

In most industrial societies today the household sector is a net source of savings while business and government borrow and invest these proceeds. Large imbalances across these groups are made up by foreign lenders (or borrowers). Many jurisdictions have created barriers to these foreign flows and redirected savings to domestic priorities. This practice is becoming more difficult as new international trade agreements (GATT, FTA and NAFTA) include provisions to allow the free movement of capital. Open capital markets that allocate savings according to risks and returns are growing rapidly.

These changes are the financial equivalent of trade liberalization and they also act to limit the extent of internal, distinct structural evolution.

2.3 Historical Analysis: Economic Change in Ontario 1971-1990

In this section of the report we revisit the elements of economic structure considering the actual performance of the Ontario economy over the past twenty years.

2.3.1 Population and the Labour Force

In 1990 the population of Ontario was 9.743 million, about 37% of the Canadian population. Over the decade of the 1970s, the rate of growth in population in the province was somewhat lower than that for the nation as a whole (1.19% versus 1.21%) which reflects outward migration from the province during most of that decade. Population growth in Ontario picked up during the 1980s as migration turned strongly positive, given the strong economic growth in the provincial economy. The net effect was to increase the average annual rate of growth in population to 1.25%; greater than the national rate of 1.1%. By 1990 the population was 25% larger than it had been in 1971.

Exhibit 2.1 compares the growth in population in Ontario with other jurisdictions by creating index numbers based in 1970.[16] Ontario's growth has been consistently among the highest and the expansion of the late 1980s carried the cumulative increase in population to the top of the list of all major industrial countries. This is just one measure that shows the remarkable boom in Ontario's economy in the late 1980s.

Over the past two decades the age distribution of the population has shifted. The population below the age of fifteen has been declining at an average rate of - 0.6% (about equal to the national average), and this age group currently represents 20.4% of the provincial population. The population in the fifteen to sixty-five age group has been growing at an average annual rate of 1.7% (which is above the national average) and currently represents 67.8% of the population. The over sixty-five age group, which represents 11.6% of the population, has been demonstrating the highest average annual rate of growth at 3% (about equal to the national average). Exhibit 2.2 illustrates this structural trend.

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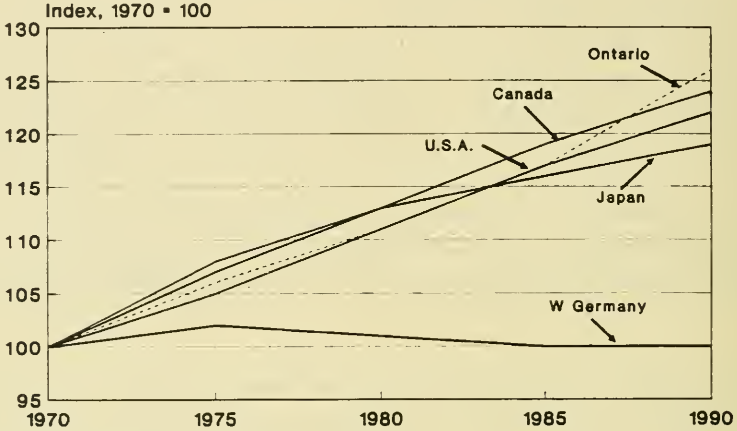
[16] Index numbers are used at several points in the study. This calculation represents the relative rate of growth for different measures by establishing a common base. In Exhibit 2.1 each country's population is divided by its 1970 level; creating a common starting point. Higher values for the index number in later years represents more rapid cumulative growth.

Exhibit 2.1

Population Trends



Source: OECD, Institute For Policy
Analysis at the University of Toronto

EXHIBIT 2.2
ONTARIO AND CANADIAN POPULATION AND SELECTED CHARACTERISTICS
1971-1991

Ontario	1971	1976	1981	1986	1991
			(Thousands)		
Births	127.1	122.7	123.0	134.4	145.5
Deaths	57.5	60.3	62.9	67.2	71.6
Net External Migration	46.6	32.5	31.0	84.8	74.0
Total Population	7703.3	8265.0	8625.0	9113.0	9891.0
			(Percent)		
Annual % Change (1)		1.4	0.9	1.1	1.7
Age Group					
0 - 14	28.7	25.1	21.9	20.6	20.4
15 - 64	63.0	66.0	68.1	68.5	67.8
65+	8.4	8.9	10.1	10.9	11.6
Canada					
Total Population	21568.0	22993.0	24342.0	25353.0	26219.0
Annual % Change (1)		1.3	1.1	0.8	0.7
Net Immigration	51.7	75.4	89.6	74.7	176.1
Ontario Population As A % of Canada	35.7	35.9	35.4	35.9	37.7

Source: Statistics Canada and Ministry of Treasury and Economics
Ontario Population Projections to 2015, June 1991 Informetrica Ltd.

(1) Compound annual rate of change for five year period ending at indicated year

This surge in population and economic activity fundamentally changed the nature of Ontario; bringing in a wave of new immigrants and creating a new generation of manufacturing and service businesses.

In 1990, it is estimated that there were 4.9 million persons within the provincial labour force. The rate of growth in the labour force was especially high during the 1970s (at 3%) and declined through the 1980s to an average of 2%. The labour force participation rate currently stands at about 69% and, over the last two decades, has increased at an average annual rate of about 0.7%. The rise in the participation rate was mostly due to the increase in the number of working women. This change, combined with the shift in the age structure of the population, created one of the important structural changes of the past twenty years. Family composition shifted from one income earner and several dependent children to two workers and few or no children. Women's lifestyles have changed most rapidly as they have added full or part time work to household management.

2.3.2 Trade, Technology, Employment and Labour Productivity

Exhibit 2.3 illustrates the points made in section 2.2.2 regarding trade orientation. Notice that total trade in Ontario (exports plus imports) is virtually as large as the total GDP. As suggested in section 2.2, this trade reliance is reduced in larger jurisdictions. In Canada the same ratio has reached just 50% of GDP and the ratio is lower in the United States. In all cases, however, the trend since 1970 has been to a greater trade orientation. As suggested above, this is consistent with increased specialization.

Technology is a major determinant of trends in production and productivity. Thus, the big gains in labour productivity during the 1960s and early 1970s encouraged the expansion of the manufacturing sector and increased incomes because of labour augmenting technologies. By the mid 1970's technology had shifted to an emphasis on energy conservation and there was an associated slump in labour productivity; even while employment continued to expand. Energy producing sectors became less important and high intensity energy using sectors declined.

These combined effects of technology and international economic conditions had a serious impact on Ontario during the last twenty years. As labour productivity slowed down and even declined in some years, there was a gradual slowdown in real wages and income gains. See Exhibit 2.4. This shift is often mentioned as an indication of Ontario's declining competitive position.[17] While the province has experienced a particularly severe loss of productivity growth, this change is part of a global trend shared by other countries.

2.3.3 Investment and Savings

The long-term rate of growth for the economy will depend on the trend rate of investment. Investments will build the new plants, housing and infrastructure to contain the new economic activity. The sources of the savings that finance this investment and the allocation of the new investment across industries are both determinants of the structure of the economy.

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[17] This theme is prominent in the recent Ontario paper on industrial policy. See, for example, Budget Paper E, p. 96-98.

Where the savings come from domestic sources they promote further growth because the proceeds remain in the province and are redistributed to local consumption. Where foreign savers finance the investment a portion of the benefits are lost as returns are paid to non-residents over the life of the investment. Ontario has been a destination for extensive foreign investment during the 1980s; partly because industrial growth required extensive new funding but also because government deficits have consumed a large portion of domestic savings. Exhibit 2.5 documents the relative importance of investment in Ontario.

The province's public sector reliance on foreign investment has steadily increased even as private sector investment subsided in 1990. In place of private investing, the government has stepped in as a major borrower. It makes little difference which level of government holds the debt. The long-term structural implications are the same as the population must allocate an ever larger share of its income to paying foreign investors interest and principal on their loans and investment. These long-term obligations to pay foreigners is another factor that will promote trade and international integration.

Manufacturing, communications and utilities and government are the capital intensive sectors and they are the destination of most of the new investment. The current recession has accelerated a trend reduction in manufacturing's share of investment and there is a notable increase in the relative importance of investment in the commercial, business and personal services sector.[18]

2.3.4 Industrial Composition

The elements of structural change detailed in this section have combined to create a distinct and changing industrial mix for Ontario. Exhibit 2.6 documents the relative shares and growth in particular industries from 1976 to 1990.

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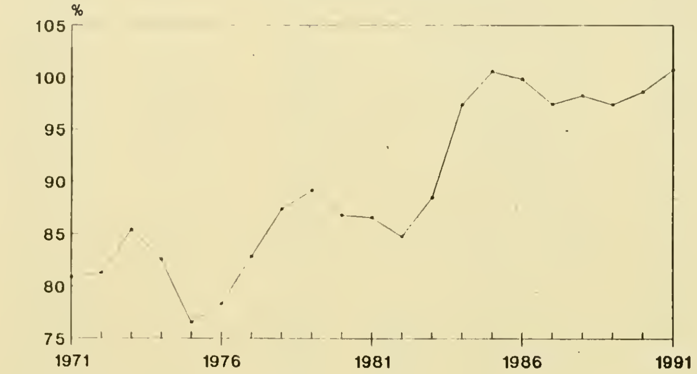
[18] The Informetrica model tracks investment and capital stock for the major industrial sectors in Ontario. This data shows that, from 1976 to 1990, capital investment built the capital stock in communication and utilities, government (and other service sectors) more rapidly than in manufacturing. This shift to investment was more pronounced in the 1980s than in the late 1970s: a result that is likely due to the recession.

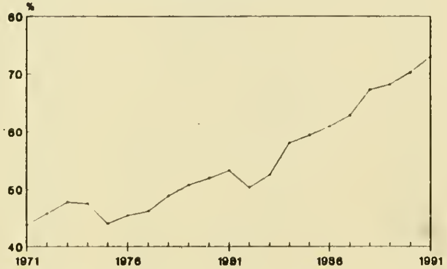
Exhibit 2.3

Total Ontario Exports Plus Imports As A % Of GDP



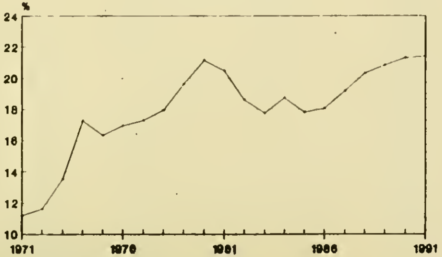
Source: Office of the Economic Policy, Ontario Ministry of Treasury and Economics, and Statistics Canada

Total Canadian Exports Plus Imports As A % Of GDP



Source: ARA Consulting \ Informetrica

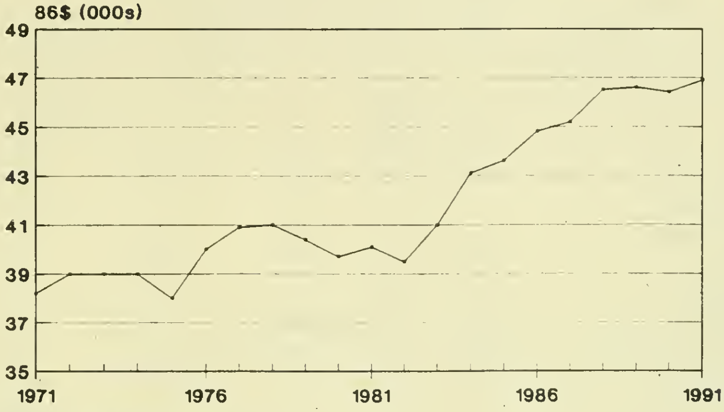
Total U.S. Exports Plus Imports As A % Of GDP



Source: ARA Consulting,
Department of Commerce

Exhibit 2.4

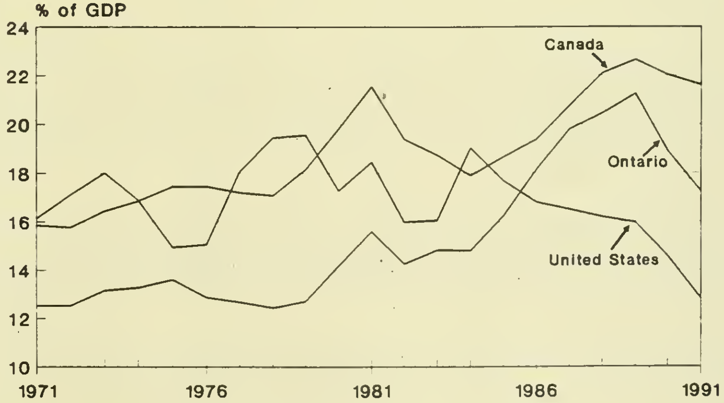
Output per Worker in Ontario



Source: ARA Consulting, University of Toronto Institute For Policy Analysis 1992

Exhibit 2.5

Business Investment As A % Of GDP



Source: ARA Consulting, Informetrica, U of T Institute For Policy Analysis, US Department of Commerce 1992

EXHIBIT 2.6
ONTARIO'S INDUSTRY STRUCTURE GROSS DOMESTIC PRODUCT SECTORAL GROWTH RATES AND RELATIVE SHARES

	Shares			Growth Rates	
	1971	1980	1990	1971-80	1980-90
Agriculture:	2.6%	2.2%	1.5%	1.6%	-0.2%
Fisheries, Forestry, Trapping & Logging:	0.4%	0.4%	0.4%	3.0%	2.4%
Mining:	4.1%	1.4%	1.6%	-8.7%	5.2%
Manufacturing:	27.5%	26.4%	25.4%	2.7%	3.3%
Construction:	7.2%	6.1%	7.1%	1.4%	5.3%
Transportation & Storage:	4.6%	4.5%	4.4%	2.8%	3.4%
Communications & Utilities:	3.8%	5.1%	5.4%	6.7%	4.3%
Trade:	11.2%	11.5%	12.5%	3.6%	4.6%
Finance, Insurance & Real Estate:	11.6%	14.2%	14.9%	5.6%	4.2%
Commercial, Business & Personal Services:	20.0%	21.7%	21.3%	4.2%	3.5%
Government:	7.0%	6.5%	5.5%	2.4%	2.0%
TOTAL:	**100.0**	**100.0**	**100.0**	**3.2%**	**3.6%**

Source: Informetrica Ltd.

The industrial composition of Ontario has shifted slowly over the past two decades. The agriculture, mining and government services sectors have experienced noticeable declines with average rates of growth (with the exception of mining during the 1980s) well below the rates for the provincial economy as a whole.

The economy is dominated by the manufacturing sector which accounts for approximately one-quarter of GDP. However, over the past two decades, the average annual rate of growth posted by this sector has been less than that posted by the aggregate of non-manufacturing sectors.

The sectors which have consistently posted the strongest rates of economic growth over the past two decades include: (i) communications and utilities; (ii) trade; (iii) finance, insurance and real estate; and (iv) the commercial, business and personal services sectors (the mining and construction sectors have also demonstrated strong economic growth over the last decade after posting poor rates of growth during the 1970s). These developments are gradually building an emphasis on the private services sector.

Industrial composition appears slightly different when viewed from an employment perspective. Over the period from 1976 to 1990, employment in the provincial economy increased from 3.65 million to 5.06 million, which represents an average annual rate of growth in employment of 2.3%. The rate of growth in employment was higher during the period from 1976 to 1980, at 2.5%, and has declined to an average annual rate of growth of 1.9% over the period from 1980 to 1990. Exhibit 2.7 describes the average annual rates of growth, and the relative shares of industrial employment.

EXHIBIT 2.7 [19]
ONTARIO'S INDUSTRIAL STRUCTURE
SECTORAL EMPLOYMENT GROWTH RATES AND RELATIVE SHARES

	Shares			Growth Rates	
	1976	1980	1990	1976-80	1980-90
Agriculture:	3.2%	3.7%	2.3%	6.3%	-2.6%
Fisheries, Forestry, Trapping & Logging:	0.2%	0.4%	0.3%	15.3%	-1.0%
Mining:	0.9%	0.8%	0.5%	-1.8%	-2.2%
Manufacturing:	23.8%	22.6%	20.3%	1.2%	-0.3%
Construction:	6.3%	5.7%	8.2%	-0.0%	5.6%
Transportation & Storage:	4.2%	4.1%	3.9%	2.1%	1.4%
Communications & Utilities:	2.7%	2.7%	2.8%	3.1%	2.0%
Trade:	20.8%	20.8%	18.7%	2.4%	0.9%
Finance, Insurance & Real Estate:	5.1%	5.6%	6.7%	4.9%	3.7%
Commercial, Business & Personal Services:	26.0%	27.5%	33.5%	3.9%	4.0%
Government:	6.8%	6.0%	5.1%	-0.5%	0.1%
TOTAL:	**100.0**	**100.0**	**100.0**	**2.5%**	**1.9%**

Source: **Informetrica Ltd.**

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[19] A consistent, sectoral time series for employment was not available for the period from 1971 to 1976.

Differences in the shifting industrial shares of output and employment are due to changes in productivity. Strong gains in employment are often focused in the service sector where productivity growth is low. In some cases the investment and capital share of industries might increase while output shares remain largely unchanged and employment shares decline dramatically. This pattern would be consistent with a major gain in labour productivity, related to the introduction of labour saving machinery but little gain in output. This pattern is roughly consistent with shifting shares in manufacturing.

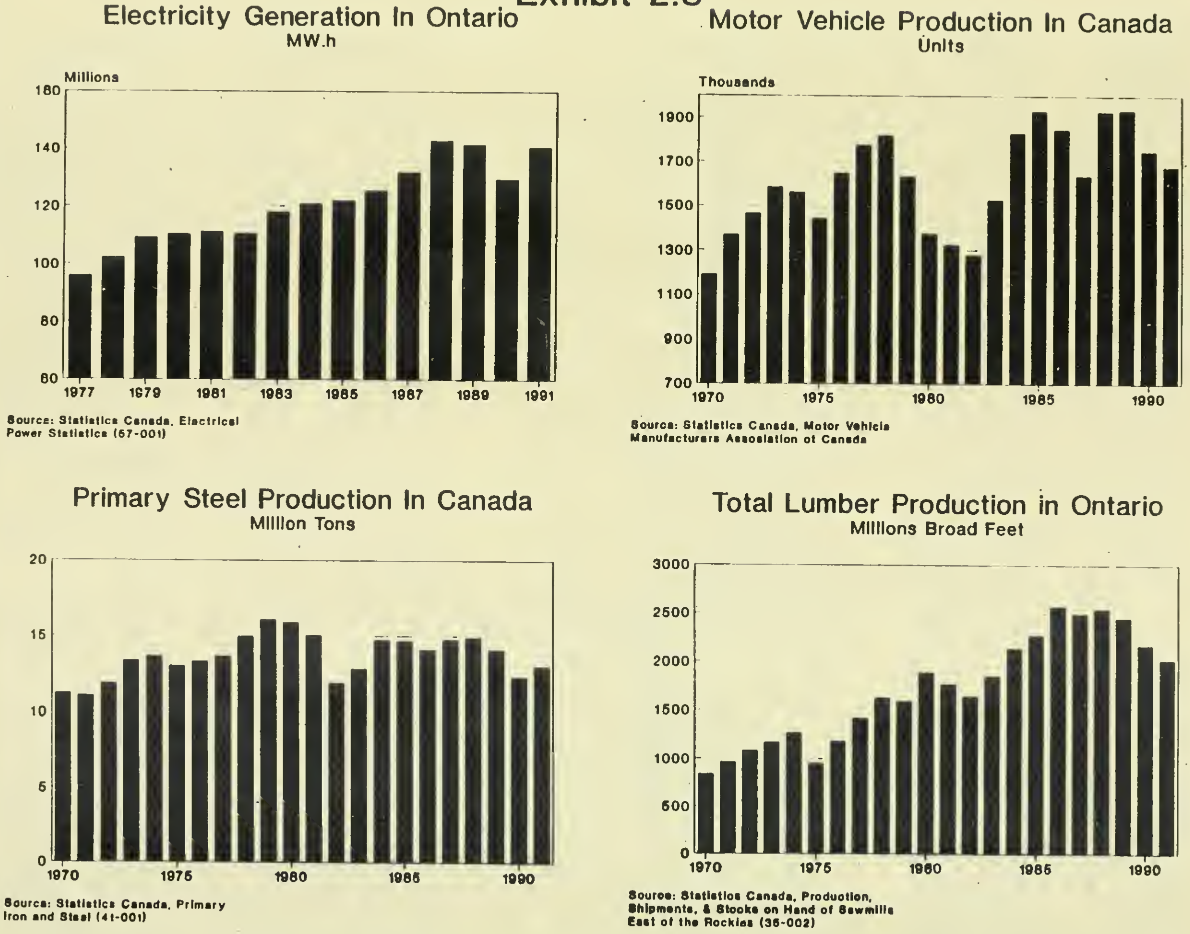
2.3.5 Other Measures of Industrial Structural Change

There are various other ways to view the recent economic development of Ontario. Exhibit 2.8 presents a series of volume or output measures of activity, all showing the continuing pattern of growth. Perhaps the most important measure of manufacturing activity is the level of production of motor vehicles. Total Canadian production is used here to build a series from 1971 (Ontario data is only available from 1976), but over 90% of production is in this province. Allowing for cyclical weakness in the early 1980s and 1990s, there is a clear upward trend.

The motor vehicle assembly industry plays a particularly important role in determining the structure of the manufacturing sector. Vehicle assembly requires extensive linkages to many supplying industries. These linkages extend through direct suppliers (engines, brake assemblies, electrical systems, suspensions, advertising, legal support, etc.) to upstream manufacturers (glass, plastics, steel, textile fabricating, etc.). These linkages are so extensive that the motor vehicle industry has one of the highest multiplier effects among manufacturing industries: i.e. a large increment of production and employment is stimulated in other industries when vehicle assembly expands.

The growing importance of trade is also complicating the matter. Suppliers to Ontario vehicle assembly are more often outside the province (and outside the major auto corporations) than before. This specialization and contracting out creates a challenge for Ontario business. As more vehicles are built here, there is a growing opportunity to sell components to the major automotive corporations. At the same time competition is increasing from more distant suppliers who are able to reach Ontario plants. This type of intra-industry trade and competition is an important determinant of future industrial composition.

Exhibit 2.8



Electricity Generation In Ontario

MW.h

Source: Statistics Canada, Electrical Power Statistics (57-001)

Motor Vehicle Production In Canada

Units

Source: Statistics Canada, Motor Vehicle Manufacturers Association of Canada

Primary Steel Production In Canada

Million Tons

Source: Statistics Canada, Primary Iron and Steel (41-001)

Total Lumber Production in Ontario

Millions Broad Feet

Source: Statistics Canada, Production, Shipments, & Stocks on Hand of Sawmills East of the Rockies (35-002)

This important structural feature was initiated with the U.S.-Canada Auto Pact in 1965 and it was reinforced by significant new investments in capacity in the late 1980s. Ontario's share of North American auto assembly capacity has grown steadily during the 1980s and this virtually assures the continuing importance of auto related activity in the 1990s.

Other measures of industrial output show similar rising trends. Lumber production rose steadily during the past twenty years. Primary steel production may have reached a plateau in the late 1980s. In all cases the measures provide a picture of the strong expansion in the mid to late 1980s and the severe slump in 1990-1991.

This section of our report has illustrated the extent of basic structural change in Ontario during the last twenty years. Demographic forces were dominated by the aging of the baby boom group born between 1947 and 1960. International trade and investment have increased and this has added to the integration of economic activity among jurisdictions. Industrial composition, measured by either output or employment has shifted from primary industries to private services. There has been a shift out of manufacturing with employment and output losing share to other sectors. Economic restructuring of the type described here has an equivalent effect on environmental conditions and these are discussed in the next section.

2.4 Historical Analysis: Environmental Change in Ontario

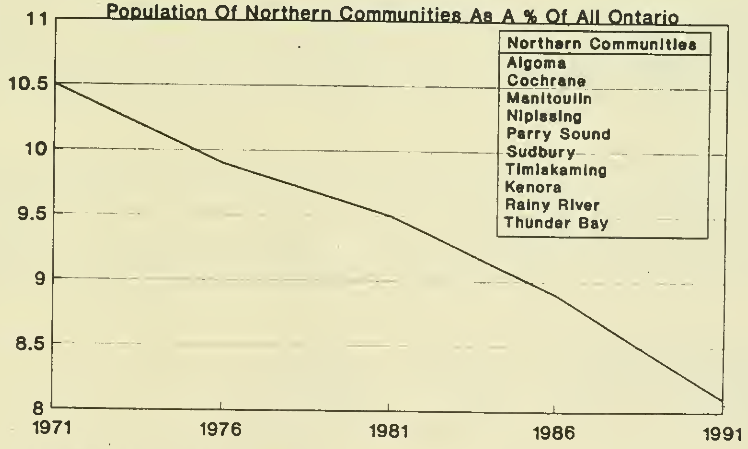
2.4.1 Resource and Material Use

Ontario is a large industrial jurisdiction with an unusual balance of natural resources and manufacturing capacity. This balance includes access to minerals, forest resources, fresh water and agriculture land in relative abundance. At the same time the province has a large manufacturing sector with an emphasis on the assembly of motor vehicles and parts. Service activities are well represented with Central Ontario offering a complete range of business services and Toronto containing a mid-sized global financial centre. There are not many other jurisdictions in the world with this resource-industrial-service balance.

Ontario's economy has followed a trend noted elsewhere in the world as the relative importance of raw materials has declined while the demand for services increases. This shift is sometimes referred to as the dematerialization of the economy. Global trends, perhaps prompted by the energy crisis, have shown a shift away from reliance on raw materials (water, base metals, primary energy) in the production of goods. For example, the average weight of a car has dropped, the energy content of chemical production is down and the reliance on heavy building materials in construction is reduced.[20]

These changes have reduced growth in the global demand for basic raw materials. In Ontario, as elsewhere, this has meant a shift in employment and output from the industries and communities that traditionally were employed in these commodities. One structural change associated with this situation is a population shift to the south - see Exhibit 2.9. This shift is the result of technological change that brings new, more sophisticated materials to the production process. While less of the old raw materials are used, they are replaced by new composites in more sophisticated products.

Exhibit 2.9
Population Shifts To Southern Ontario



Source: Statistics Canada and Ministry of Treasury and Economics

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[20] Research on these trends is described in the OECD publication "The State of the Environment" (Chapter 11). Reduced energy use and substitution away from basic new materials is cited. The publication argues that the growing complexity of industrial processes is increasing the risk of environmental damage.

Global demand for raw materials will be affected by these emerging trends in material use and this will have an impact on demand for Ontario's materials. But these global trends in demand for raw materials are not the only factor determining Ontario's production. Another factor determining the production of most resources is their production costs and access to foreign markets. Some of the province's raw materials have improved their share of the world market. For example, the discovery of rich gold mines north of Lake Superior has boosted Ontario's share of the world's gold production. On the other hand, depleting reserves and rising costs of production for iron ore have virtually eliminated this commodity from provincial production.

The demand and supply for Ontario's industrial raw materials is more closely tied to these conditions (technology and production costs relative to other jurisdictions) than to the composition of industrial demand in the province. International trade intervenes in the production chain so that, for example, relatively little of Ontario's base metals (zinc and nickel) production would find its way into Ontario steel related products. Trade is so pervasive at all stages of production that raw material demand and supply is decoupled from the manufacture of final consumer products. Certain materials (concrete, lumber and aggregate for example) are not shipped long distances and are thus more closely tied to provincial activity. Even here, however, most of the material will be included in intermediate goods and exported rather than consumed domestically.

For many of Ontario's primary products the generally favourable local supply conditions have permitted an increase in production in spite of the dematerialization trend. Production of Ontario's natural resources has generally increased over the last 15 years, as illustrated in Exhibits 2.10 to 2.15. The following changes in consumption/production of key resources are of note:

▪	roundwood production	+115%	1975-1989
▪	non-metals	+ 50%	1975-1989
▪	structural materials	+ 50%	1975-1989

In addition, energy consumption has increased 10% between 1978 and 1989 notwithstanding the oil shocks and recessions experienced through that period. This increase in consumption must be set against the distribution of the supply of energy in the Province: a 77% dependence on non-renewable fuels (see Exhibit 2.14).

An important exception to this trend increase in resource use is the production of metals which has declined almost 70% since 1975. As noted above, this decline is associated with diminishing reserves and increasing production costs (see, for example, the trend in reserves for a selected group of metals in Exhibit 2.12).

Water use (Exhibit 2.15) reflects a more complex pattern of resource use.[21] Water intake has remained relatively constant in manufacturing although net consumption has declined by about 25%, reflecting a greater degree of recirculation. By contrast, water intake by the mining sector has increased significantly and net consumption has remained steady. Again, this trend is consistent with increased emphasis on recirculation and, in the case of mining, may reflect increased concerns with water contamination and management.

Water use in the thermal power industry shows a very different pattern: intake has remained relatively constant yet net consumption increased dramatically between 1981 and 1986. There is no obvious explanation for these changes, although it may be related to the increased share of nuclear power.

Overall, industrial use (thermal + manufacturing + mining) has increased stress on water resources: water intake has more than doubled and net water consumption has increased about 50%.

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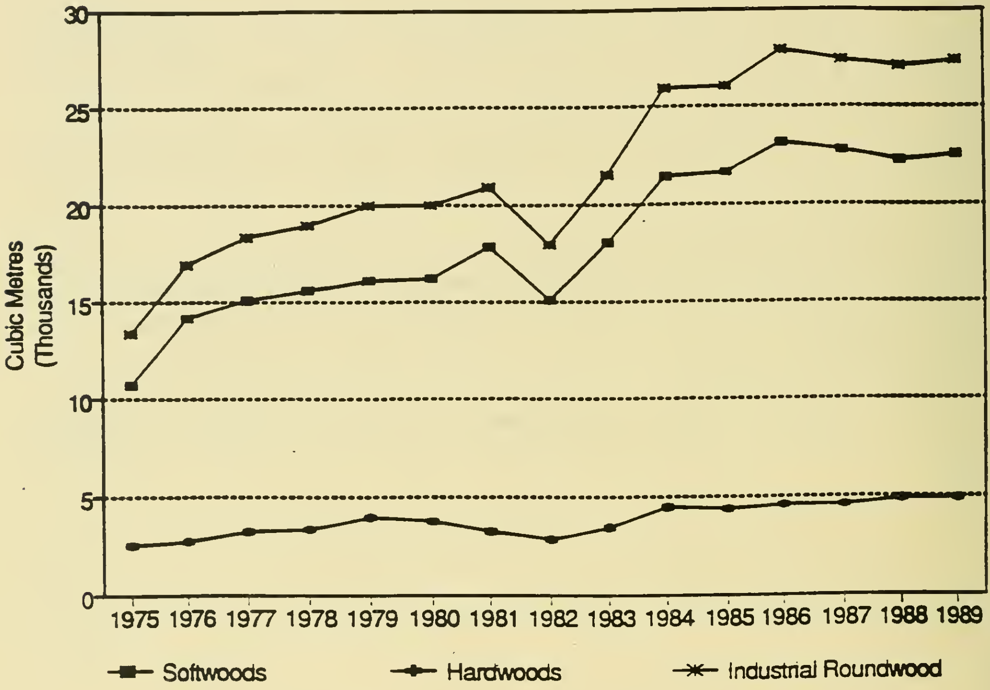
[21] The historical pattern of water use should be treated with caution, as data are only available for three census years: 1976, 1981, and 1986.

Exhibit 2.10: Ontario Forestry Production* 1975 - 1989



Source: Statistics Canada Catalogue 25-202

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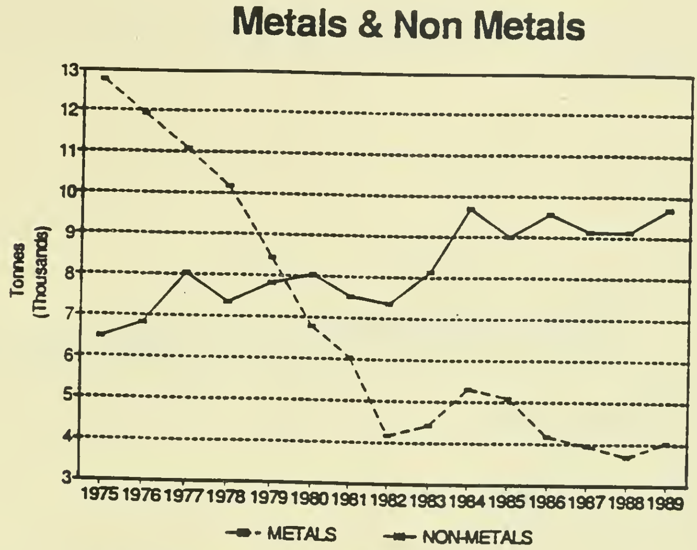
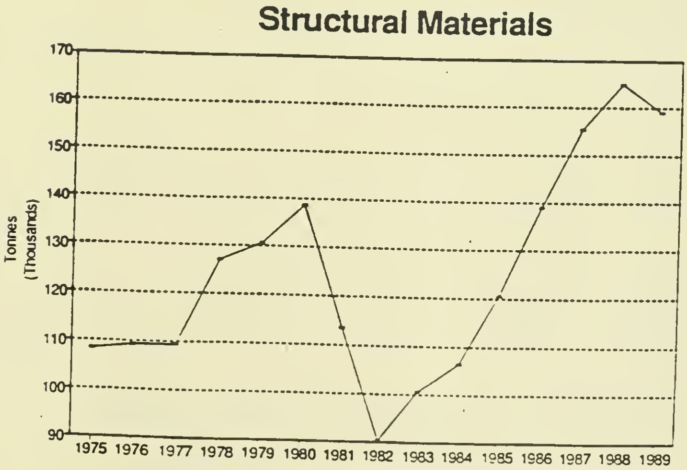
* Industrial roundwood production

Exhibit 2.11: Ontario Mining Production 1975 - 1989

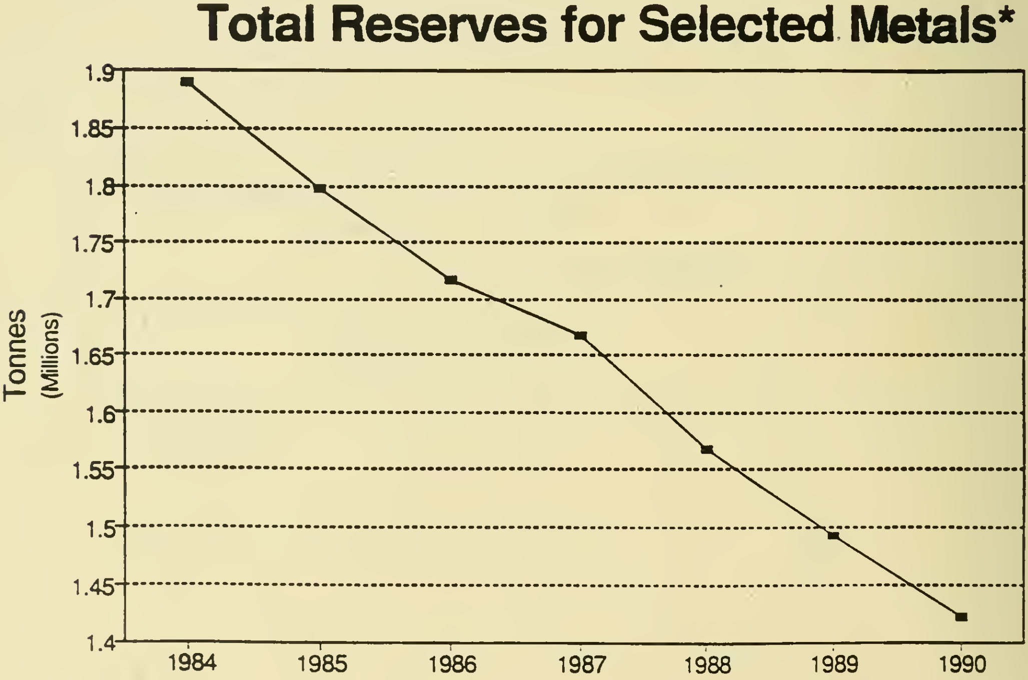


Source: Statistics Canada, Catalogue 26-201



Source: Statistics Canada Catalogue 26-201
Structural Materials include gypsum, clay, sand, gravel, etc.

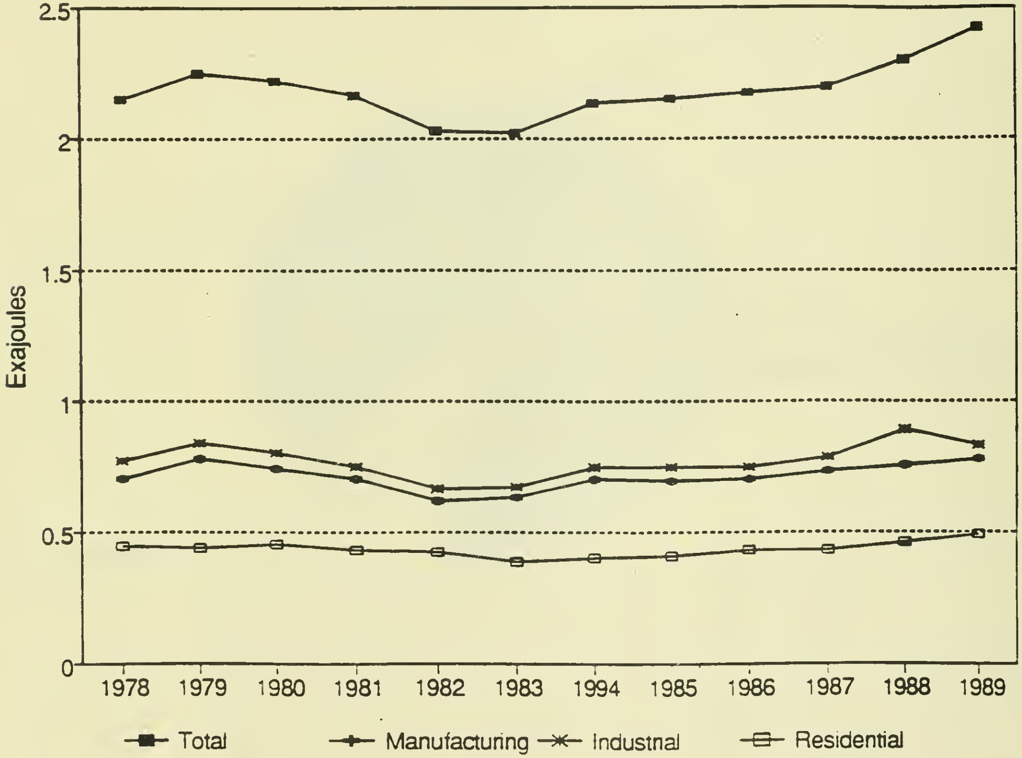
Exhibit 2.12: Ontario Mining Reserves for Selected Metals 1984 - 1990



* Includes: copper, nickel, zinc, gold, silver, molybdenum and lead

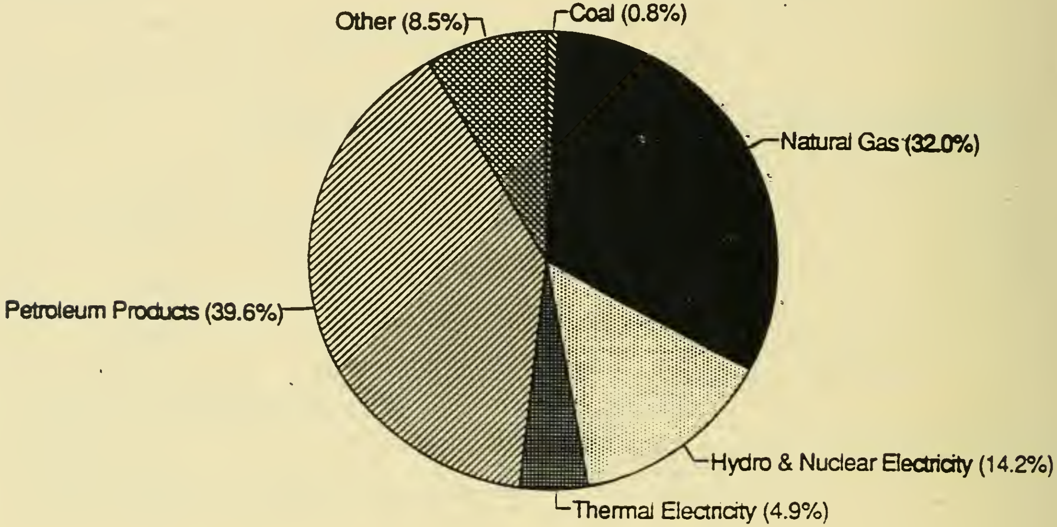
Source: Energy Mines and Resources, Canadian Yearbook

Exhibit 2.13: Ontario Energy Consumption 1978 - 1989



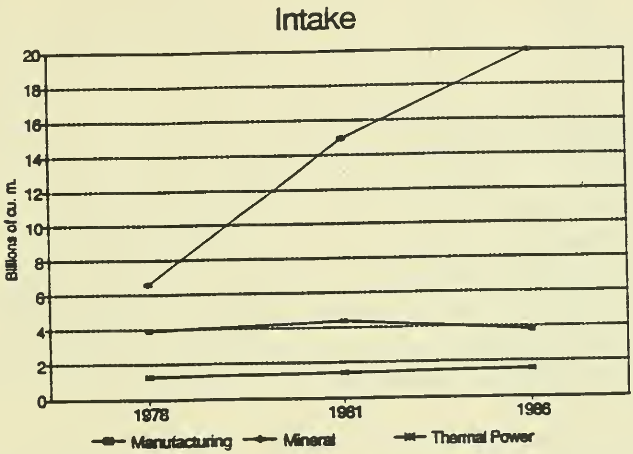
Source: Statistics Canada - Quarterly Report on Energy Supply - Demand in Canada (57-003)

Exhibit 2.14: Ontario Composition of Net Energy Supply 1989

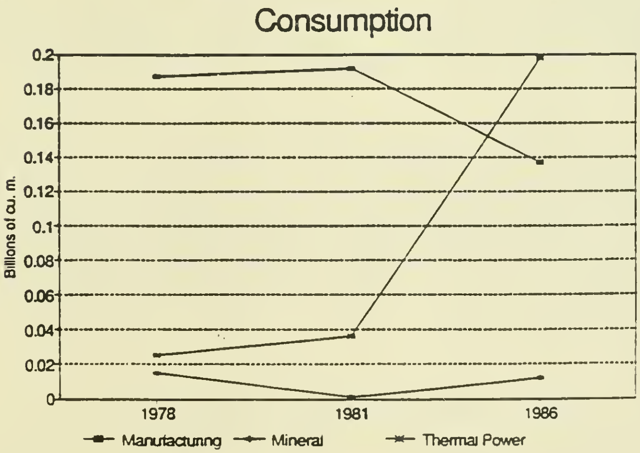


Source: Statistics Canada - Quarterly Report on Energy Supply - Demand in Canada (57-003)

Exhibit 2.15: Ontario Industrial Water Use



Source: Environment Canada Economics & Conservation Branch
Ecosystem Sciences and Evaluation Directorate



Source: Environment Canada Economics & Conservation Branch
Ecosystem Sciences and Evaluation Directorate

2.4.2 Sustainable Development in Ontario

In order to comment on the sustainability of resource use over the 1971 to 1990 period, resource consumption figures need to be compared to some benchmark that reflects the availability and quality of the resource in question. In the case of non-renewable resources a possible benchmark is reserves, whereas for renewable resources, a possible benchmark is some measure of sustainable yield.

Unfortunately, data for these benchmarks are either not available or are incomplete. For example, Exhibit 2.11 indicates that production of metals declined precipitously over the 1975 to 1988 period (on a volume basis). Based on these data and the sharp decline in reserves of selected metals illustrated in Exhibit 2.11, one might surmise that production of metals has been unsustainable. However, the data on reserves is limited -- they are for only a few metals and date back to 1984 only.[22] Furthermore, reserves are themselves a function of exploration efforts and do not provide information on the quality of ore available. Hence, the conclusion of unsustainable metal production requires much more detailed analysis of exploration activity and success rates, and the relative quality of recent discoveries.

Benchmarks for other resource use patterns are even more difficult to isolate and require further analysis and investigation that is not possible within the scope of this study. For example, there remains an ongoing debate about the sustainability of (extractive) use of forest resources. Estimates of sustainable yield (e.g., mean annual increment) do exist[23] but interpretation of those data, and in particular, comparison with harvest rates is a delicate exercise, requiring more resources and more detailed, sectoral expertise than are combined in this study.

Finally, reserve/sustainable yield information is not available for some resources or is not available in the format needed. This holds for water and energy reserves. In the case of energy reserves, an assessment of the sustainability of energy consumption from the perspective of resource availability would require an analysis of (at a minimum) Canadian energy demand and supply issues, as Ontario is highly dependent on imports of energy resources from outside the Province. Ontario's rate of energy consumption can already be considered "unsustainable" if a strict, provincial perspective is held.

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[22] Pre-1986 data on reserves is less reliable and reported on a different basis.

[23] See, for example, work by Stephen Gray of the Petawawa National Forestry Institute in Chalk River, Ontario (unpublished).

In summary, historical production/consumption data are available for most resources. However, the dearth of reserve/sustainable yield data -- as well as definitional problems with the term "sustainability" -- precludes comparisons of resource availability and consumption and, consequently, defensible assessments of the sustainability of resource use in Ontario over the 1971-1990 period.

The preceding paragraphs focus on "traditional" resources. Environmental resources such as air, water and climate are equally important to the welfare of the people of Ontario as the traditional components. There is no question that the 1971-1990 period has seen an extraordinary increase in awareness, concern, and scientific understanding of multiple environmental resource issues.

In some cases, it is clear that human activity have destroyed some environmental resources (e.g., development of wetland). However, assessment of the sustainability of current levels of waste generation is a highly complex ecological question that can only be fully addressed on a contaminant/location/resource-at-risk-specific basis. For example, the impact of acid deposition levels differs from one location to another depending on the buffering capacity of the deposition area.

Furthermore, data are not available that enable an assessment of whether the use of environmental resources has become more or less sustainable over the last two decades. In fact, collection of point of emission data is still in its early years: values are available for only a one (or at best a handful) of years so that time-series comparisons are not possible; and new indicators of sustainability are evolving so that the data currently available may not represent a full picture of sustainability.

In summary, then, an historical assessment of the sustainability of the use of environmental resources (i.e., the level of waste generation) falls, at present, on anecdotal and fragmented evidence. Data to track levels if waste generation and the analysis of waste generation relative to absorptive capacity on a general level -- the foundations of a quantitative analysis of sustainability -- are not available.

2.4.3 International Comparisons

The question of environmental restructuring was addressed from an international perspective in the OECD publication; "The State of the Environment" (OECD 1991). This international comparison revealed an extensive deindustrialization among seven major nations. It was generally observed that growth in material-intensive industries (iron and steel, primary chemicals, petroleum refining, etc.) was less than growth in "non-material" industries (specialty chemicals, electrical machinery, motor vehicles, etc.). The same study highlighted the growing importance of trade in both traditional and new industries.

In general, these trends apply in Ontario and are built into the current study. To investigate the relative importance of these trends in Ontario compared to the major OECD economies, the study team compiled comparable data for the province. Exhibits 2.16 and 2.17, reproduce key findings from the OECD study and add Ontario data. Exactly comparable data is not available. For Ontario the exhibits show changes in real GDP by industry while the national statistics from the OECD are for industrial production indices. These data problems likely make some comparisons (e.g. for petroleum refining) inaccurate. However, the general pattern is the same with Ontario showing slow growth or declines in production among heavy industries and strong growth for high value, non-material industries.[24]

For example, Ontario shows a similar jump in chemical, paper and electrical machinery production to other industrial jurisdictions. The relative changes in iron and steel and petroleum refining are more difficult to interpret but this is likely do to the data difficulties noted above. In general it appears that growth in environmentally sensitive industries has continued through the 1970s and 1980s but at a slower pace than the overall economy.

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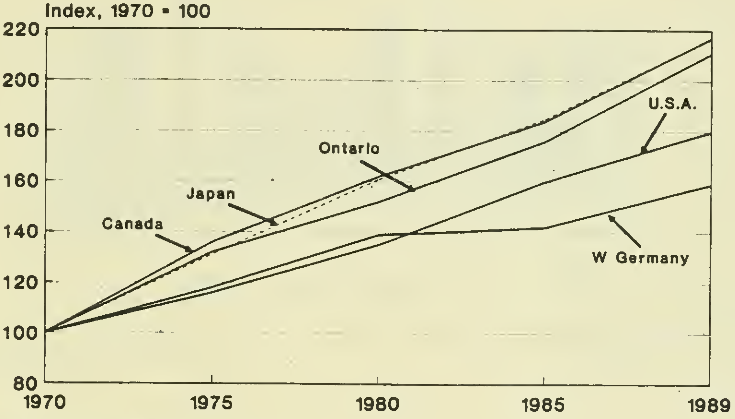
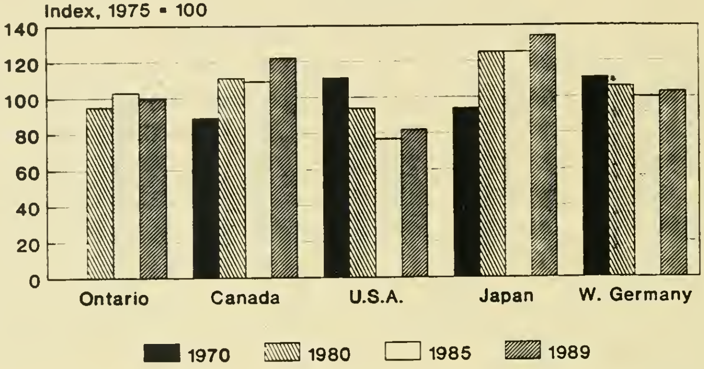
[24] The study team tried to build Ontario specific measures for the concepts contained in Chapter __ of the OECD "State of the Environment". This effort was frustrated by several small but difficult barriers. For example the OECD national data for industrial production indexes was used as a base for many calculations and there is no comparable measure for Ontario. Provincial Gross Domestic Product is a weak but plausible alternative but this series only begins in 1971; making comparisons with the OECD indexes based in 1970 a problem. Comparable Ontario for other measures was either not available or beyond the projects resources to collect and chart.

Exhibit 2.16
Private Consumption



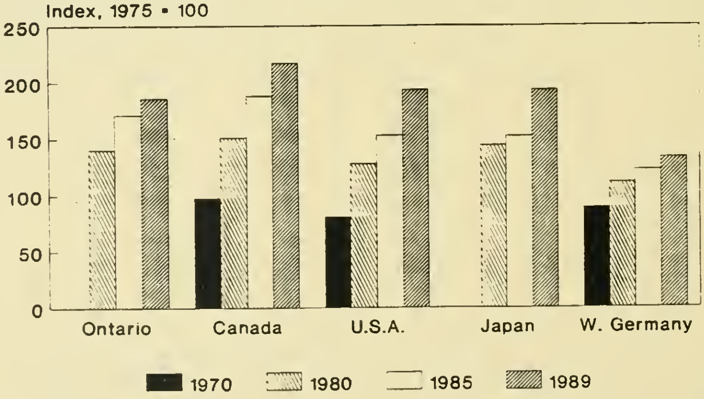
Source: OECD, Ontario Ministry of Treasury and Economics, Statistics Canada Price Indexes

Exhibit 2.17
Changes in Industrial Structure
Iron & Steel



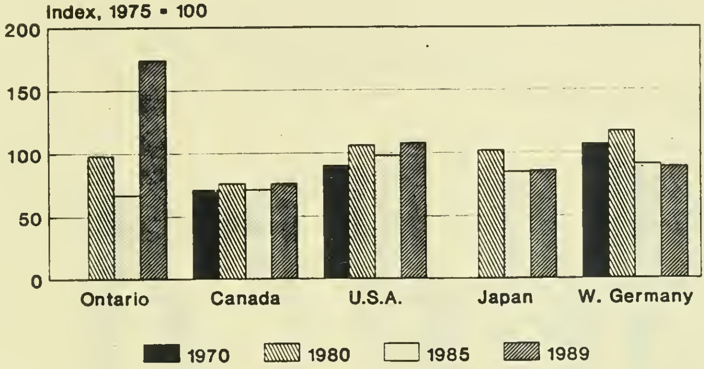
Source: OECD, Informetrica,
Statistics Canada Cat. No. 15-512

Chemicals



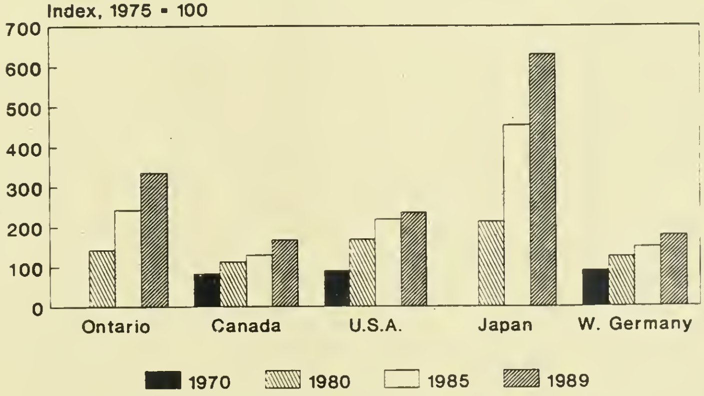
Source: OECD, Informetrica,
Statistics Canada Cat. No. 15-512

Exhibit 2.17 (cont'd)
Changes In Industrial Structure
Petroleum



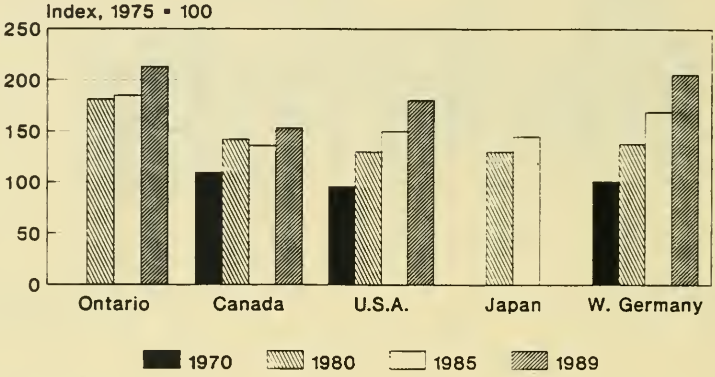
Source: OECD, Informetrica,
Statistics Canada Cat. No. 15-512

Electrical Machinery



Source: OECD, Informetrica,
Statistics Canada Cat. No. 15-512

Exhibit 2.17 (cont'd)
Changes In Industrial Structure
Pulp and Paper



Source: OECD, Informetrica,
Statistics Cansda Cat. No. 15-512

2.5 Summary

In this chapter we have described five elements of structural change and applied them to the experience of Ontario economy in the past twenty years. We see that structural change is a complex process involving technology, trade, demographics, investments and government policy. While each of these plays a role, we argued that technology and trade will be the dominant factors in the 1990s. Government policies will play a more modest role in determining structure because of budget problems and the trend to international trade and investment agreements that limit government authority.

The environment itself was also described as a contributing factor. As evidence grows of long term environmental costs associated with economic expansion, international treaties, local government regulations and competitive forces will make environmental objectives a force for restructuring. This factor is not easily included in the traditional economic data and models. In the next chapter we will create two special scenarios designed to describe the impacts of environmental restructuring.

3.0 FIVE PROJECTIONS FOR ONTARIO'S ECONOMY (1992-2010)

This section of the report describes five alternative projections (a Base Case and four scenarios) of the development of the Ontario economy over the next twenty years. Each scenario is designed to illustrate the impact of one or more of the key factors described in Chapter 2.

The starting point for all of these projections is a Base Case that describes the most likely trends. Four scenarios are then derived as variations on the Base Case with each scenario reviewing a different aspect of structural change. The first scenario considers the effect of stronger foreign growth in the Base Case. The second scenario extends the stronger growth results in Scenario 1 by adding domestic policies designed to improve productivity. A third scenario further extends the results of Scenario 2 by assuming new environmental policies designed to alter economic structure and to relieve ecological damage.

The first three scenarios build on each other; gradually adding to economic growth and shifting resources to reflect various social priorities. In particular, Scenarios 2 and 3 are intended to simulate the impact of government intervention that targets first higher labour productivity and then improved environmental conditions.

The fourth scenario is deliberately different in its structure. Rather than impose changes through the exogenous variables and other levers of the econometric model, this scenario begins with the industrial structure (essentially the composition of industrial output) found in the Base Case. This structure is directly changed by assuming that trends over the 1991 to 2010 period are extensions of changes that occurred from 1976 to 1990. This scenario is intended to impose much more dramatic structural change and isolate the impacts of the shifting industrial composition towards services and away from raw materials and primary manufactures.

Each section of this chapter reviews one of these proejctions: covering the key assumptions and comparing the results to the Base Case.

<table>
<tr><th colspan="3">THE FIVE PROJECTIONS</th></tr>
<tr><th>Name</th><th colspan="2">Description</th></tr>
<tr><td rowspan="3">Base Case</td><td colspan="2">Population growth slightly below 1976 to 1991. International growth is weaker than in the past because of high real interest rates. U.S. growth is restrained by high taxes. Canadian growth is skewed in the first ten years by recovery from the recession. Manufacturing expands relatively quickly.</td></tr>
<tr><td></td><td><i>Compound Annual Growth
1992 - 2010</i></td></tr>
<tr><td><i>National Population</i>
<i>U.S. G.D.P.</i>
<i>Canadian G.D.P.</i>
<i>Ontario G.D.P.</i>
<i>Ontario Employment</i></td><td>1.0
2.7
2.7
3.0
1.4</td></tr>
<tr><td rowspan="3">Scenario 1
International Growth</td><td colspan="2">Built by adding to the Base Case. By 2010 the European and U.S. economies are 20% larger than in the Base Case. This creates higher demands for Ontario exports. Immigration into Ontario adds to labour supply and prevents shortages. Increased government revenues are used to reduce the deficit. Production technologies are not changed.</td></tr>
<tr><td></td><td><i>Compound Annual Growth
1992 - 2010</i></td></tr>
<tr><td><i>Ontario G.D.P.</i>
<i>Ontario Employment</i></td><td>3.6
2.0</td></tr>
<tr><td rowspan="3">Scenario 2
Labour Productivity</td><td colspan="2">Built by adding to Scenario 1. Government uses the new revenues related to increased growth to improve education and build infrastructure. Private firms invest in new machinery and equipment. Labour productivity improves and real incomes rise. Much of the new wealth is transferred to foreign creditors. Higher productivity reduces labour requirements. Production technologies are not changed.</td></tr>
<tr><td></td><td><i>Compound Annual Growth
1992 - 2010</i></td></tr>
<tr><td><i>Ontario G.D.P.</i>
<i>Ontario Employment</i></td><td>3.8
1.8</td></tr>
<tr><td rowspan="3">Scenario 3
Environmental Initiatives</td><td colspan="2">Built on Scenario 2. Environmental initiatives total 80 billion nationally and 30 billion (1991$) in Ontario. Spending flows to environmental protection industries. Some assumed shift in consumer spending and industrial production patterns.</td></tr>
<tr><td></td><td><i>Compound Annual Growth
1992 - 2010</i></td></tr>
<tr><td><i>Ontario G.D.P.</i>
<i>Ontario Employment</i></td><td>3.8
1.8</td></tr>
<tr><td>Scenario 4
Industrial Shift Case</td><td colspan="2">Built on the Base Case. Industry shares are altered to simulate the effects of extended reductions in relative shares for raw material and primary industries while service industries continue to expand. Patterns of industrial shift are determined by historical trends from 1976 to 1990.</td></tr>
</table>

3.1 The Base Case/Slow Growth

This first projection presents the most likely trends for the Ontario economy during the 1990s and the first decade of the next millennium.[25] Highlights and key assumptions include:

- Population growth follows the current trend projections; showing slightly lower growth than in the 1976 to 1991 period.
- International economic problems slow economic growth and cause European currencies to depreciate relative to North America.
- Weak productivity growth and high real interest rates slow U.S. economic growth.
- Tight monetary policy in Canada keeps interest rates high and limits growth.
- Limited expansion in government spending on infrastructure spending and weak private investment limit improvements in productivity and exports.
- During the 1992 to 1995 recovery phase, employment growth will be centred in the durable goods manufacturing, construction and services sectors.
- Over the longer term the trend for stronger growth in service industries persists.
- Groupings of environmental sectors according to growth shows that resource intensive and air/water polluting industries grew at well below average rates from 1976 to 1991 and this is projected to continue into the future.

3.1.1 Background and Key Assumptions

By the year 2010 there will be 12.5 million people in Ontario, up 26% from the 9.9 million population in 1991. This growth is just slightly below the experience from 1971 to 2010. Canadian immigration rises above the levels permitted in the 1980's but remains below targets announced in recent policy. This shortfall is due to slow growth and reduced labour demand. Birth rates are down modestly from the 1970s and 1980s. Ontario's share of Canadian immigration rises slightly from the levels of the late 1980s and the province manages moderately stronger population growth than the rest of the country. Demographic assumptions for Canada and Ontario are taken from the mid range of the standard Statistics Canada and Ontario Treasury and Economics projections. Exhibit 3.1 summarizes the background projections.

While there is a general stability in the overall growth in the population, the impact of the "baby boom" from 1947 to 1961 will create a "bulge" in the age distribution well into the next century. There is a corresponding limit in the growth in the population of younger people. These trends will shift the composition of economic activity as demands for education, health care, housing and other goods and services shift in response to the composition of the population.

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[25] The Base Case scenario for Ontario is taken from the Informetrica Fall 1991 Reference Forecast for Canada and Ontario.

EXHIBIT 3.1
BASE CASE - POPULATION ASSUMPTIONS
PROJECTED ONTARIO POPULATION AND SELECTED CHARACTERISTICS, 1991-2010

Ontario	1991	1996	2001	2006	2010
			(Thousands)		
Births	145.5	141.4	135.9	133.9	136.4
Deaths	71.6	75.5	81.0	86.3	89.8
Net External Migration	74.0	107.0	69.0	72.0	74.0
Median Age (Years)	33.6	35.2	37.0	38.6	39.7
Total Population	9890.9	10737.6	11452.0	12056.7	12536.7
			(Percent)		
Annual % Change (1)	1.7	1.7	1.3	1.0	1.0
Age Distribution					
0 - 14	20.4	20.1	19.3	18.1	17.1
15 - 64	67.8	67.3	67.5	68.1	68.2
65+	11.6	12.5	13.2	13.8	14.7
Canada					
Population	26219.0	28802.0	30418.0	31940.0	33143.0
Annual % Change (1)	0.7	1.9	1.1	1.0	0.9
Net Immigration	176.1	162.7	157.9	164.1	168.9
Ontario Population As A % of Canada	37.7	37.3	37.6	37.7	37.8

Source:
Statistics Canada and Ministry of Treasury and Economics
Ontario Population Projections to 2015, June 1991

(1) Compound annual rate of change for five year period ending at indicated year

This projection presents a cautious view of the future; assuming that most of the problems that now trouble the international economy remain for the next twenty years. It assumes that the integration of Eastern Europe economies goes badly, increasing demands for capital and raising interest rates. A global capital shortage and high interest rates are a result. Inflationary pressures in Eastern Europe and supply constraints reduce European exports and competitiveness. European currencies depreciate against North American currencies. Exhibit 3.2 summarizes international and financial features of the base case.

EXHIBIT 3.2
BASE CASE - INTERNATIONAL AND FINANCIAL ASSUMPTIONS 1986-2010

	1986	1991	1996	2001	2006	2010
U.S. GNP (Bn$82)	3717.9	4144.7	4760.6	5360.1	6030.3	6695.4
Annual % Change (1)		2.2	2.8	2.4	2.4	2.7
U.S. GNP Deflator (1982=100)	1.1	1.4	1.6	1.9	2.2	2.4
Annual % Change (1)	-	3.7	3.0	3.5	3.1	2.6
U.S. WPI Oil ($C/bbl)	19.7	21.0	26.6	34.5	44.0	52.8
U.S. 90 Day Commercial Paper Rate	6.70	6.20	5.90	5.90	5.20	4.60
GDP G7 Countries Excluding Canada (1982=100)	116.0	136.5	156.6	178.1	202.1	224.5
Canada						
90 Day Commercial Paper	9.16	8.94	6.25	5.55	5.78	4.83
Real 90-day Rate	6.78	5.33	3.90	3.20	3.43	2.60
Corporate Profits As A % of GDP	9.0	5.4	8.1	8.1	8.0	9.2
Exchange rate (cents U.S. /$Can)	71.97	87.5	87.5	87.5	87.5	87.5

Source:
ARA Consulting
Informetrica Ltd.

(1) Compound annual rate of change for five year period ending at indicated year

Weak productivity, minimal reductions in defense spending and high interest rates slow U.S. growth. A high U.S. dollar reduces trade. The U.S. federal deficit remains high relative to GDP and this creates a steady increase in taxes. High real interest rates and tight monetary policy are required to fight inflation. Slow growth in the United States will limit demand for a wide range of basic commodities.

Global terms of trade show reduced prices for base metals, forest products, basic agricultural products and processed manufactured products. Relative energy prices rise due to reduced production in the Soviet Union. High value added manufactured goods rise in relative price.

Canada faces limited international demand and persistent domestic inflation. Monetary policy remains tight as inflation rises above the Bank of Canada's targets in 1992-1993. The tax regime incorporates the features of the 1987 reform. Revenues lag as the economy is weak and real income growth is very low. Government spending is curtailed by high interest costs and a high deficit. Real government spending on most programs is cut back as federal responsibilities are transferred to the province. Mandatory increases in transfers to persons and the provinces squeeze other types of spending. The deficit is gradually reduced as a percent of GDP. Provincial and local governments acquire new policy prerogatives but the revenue transfers are not sufficient to cover new costs. Deregulation in financial services, transportation, trade and energy gradually gives way to new regulations largely at the provincial level.

Low business capital spending and low government support for infrastructure and education restrict overall growth potential and trends in productivity improvements. Investment spending increases slowly as a percent of GDP -- residential construction shows the smallest increase while machinery and equipment spending is increased due to environmental regulations. Exhibit 3.3 shows the growth and composition of expenditures in the province and Exhibit 3.4 summarizes labour market conditions.

Gains in industrial production are limited as resource prices are declining and manufactures are not competitive. Import growth is held back by weak growth in real incomes. Inflation remains in the 3-4% range, above the Bank of Canada guidelines. This reflects rigidities and market barriers among and within the provinces.

EXHIBIT 3.3
BASE CASE - NATIONAL ECONOMIC ASSUMPTIONS
EXPENDITURES 1986-2010

	1986	1991	1996	2001	2006	2010
	(Millions of 1981 $)					
Gross Domestic Product	409041.3	456138.0	535875.9	600196.1	682084.8	759947.7
Annual % Change (1)		2.2	3.3	2.3	2.6	2.7
Consumption expenditure	226986.4	258193.1	287788.6	309945.7	331162.4	354693.8
Annual % Change		2.6	2.2	1.5	1.3	1.7
Government expenditure	86749.7	101243.9	108437.1	117680.8	128742.7	137747.3
Annual % Change		3.1	1.4	1.6	1.8	1.4
Investment	79334.6	98558.4	135889.9	172395.4	219534.7	265663.3
Annual % Change		4.4	6.6	4.9	5.0	4.9
Residential	25189.6	26671.7	33073.1	37328.8	43443.7	49167.5
Annual % Change		1.1	4.4	2.5	3.1	3.1
Nonresidential	22136.7	26940.4	35201.8	41527.2	46637.5	52122.6
Annual % Change		4.0	5.5	3.4	2.3	2.8
Machinery and Equipment	32008.4	44946.8	67615.0	93539.4	129454.1	164373.2
Annual % Change		7.0	8.5	6.7	6.7	6.2
Exports	131786.7	166068.9	205248.5	232368.0	269772.8	305128.4
Annual % Change		4.7	4.3	2.5	3.0	2.5
Imports	117482.5	163811.9	205515.5	234554.6	269427.3	306657.6
Annual % Change		6.9	4.6	2.7	2.8	2.6

Source:

History: Ontario Treasury and Economics,
Forecast: ARA Consulting, Informetrica Ltd.

(1) Compound annual rate of change for five year period ending at indicated year

EXHIBIT 3.4
BASE CASE - NATIONAL ECONOMIC ASSUMPTIONS
LABOUR MARKETS 1986-2010

	1986	1991	1996	2001	2006	2010
Source Population	18367.8	20753.7	22316.8	238819.3	25360.7	26562.9
Annual % Change (1)		2.5	1.5	1.3	1.3	1.2
Labour Force	11899.2	13774.7	15000.5	16067.0	16955.1	17512.1
Annual % Change		3.0	1.7	1.4	1.1	0.8
Employment	11001.3	12350.3	13557.8	14444.1	15302.9	15941.4
Annual % Change		2.3	1.9	1.2	1.2	1.1
Unemployment Rate	7.5	10.3	9.6	10.1	9.7	9.0
Output per Employee($81)	30601.9	34013.6	36649.1	38295.6	40652.7	43038.2
Annual % Change		2.1	1.5	0.9	1.2	1.4
Wages per Employee($C)	18953.7	32971.8	39007.1	46415.4	54678.5	62323.0
Annual % Change		11.7	3.4	3.5	3.3	3.3

Source:
ARA Consulting
Informetrica Ltd.

(1) Compound annual rate of change for five year period ending at indicated year

3.1.2 The Base Case Scenario for 1992 to 2010

The Base Case scenario is described in two sections. The first section deals with the expected recovery from the 1990-1991 recession and a second section deals with longer term growth prospects between 1996 and 2010.

This study tries to isolate structural or longer term trends in the economy and distinguish them from cyclical or short term changes. The severity and duration of the 1990-1991 recession, coming at the very start of the projection period, makes this difficult and requires that we discuss the base case as two distinct periods -- recovery and longer term. Comparisons of structure, growth and changes relative to the base case will be biased by the extraordinary nature of the 1991-1992 data. In particular, employment, output and investment levels are very low in manufacturing, construction and primary industries.

The Recovery Period - 1992 to 1995

The current recession ends in 1992 and a modest recovery begins; sustaining expansion into the mid 1990s. Provincial growth (measured in real G.D.P.) remains above 5% over the period from 1992 to 1994, which is about 1% higher than that expected in the national economy. The industries leading this improvement in economic growth will include motor vehicles and parts production, electrical products, construction and, given a recovery in export markets, primary metals.

Automobile sales in the U.S. are expected to rebound from declines of 4% and 12% in 1990 and 1991 respectively, and increase by 4% to 10% from 1992 to 1995. Thus, automobile exports are expected to do particularly well in 1992, and will continue to grow by more than 9% over the 1993 to 1994 period. Auto parts industries also share in the recovery, expanding by 11% from 1991's depressed levels. The combined impact of improvements in both vehicle and auto part sales is expected to push growth in the Canadian motor vehicle industry into the double-digit range over the 1992 to 1994 period.

An improvement of this magnitude in the auto industry is consistent with Ontario's new, larger share of North American vehicle production capacity. Even a modest recovery in continental demand will create major expansion in Ontario. This large shift in production during the recovery alters the composition of the economy and increases the relative role of manufacturing.

The resurgence in motor vehicle and auto parts production will filter down through the manufacturing sector and, particularly, to the primary metals, textiles and electrical equipment industries. These industries will experience a robust comeback, although it will be slightly weaker than that experienced by the automotive industry.

With the recovery, the construction industry will once again post strong rates of growth; however, activity levels similar to those enjoyed in 1989 are not expected to materialize before 1994. The construction industry benefits from a substantial increase in housing starts, as a return to pre-1990 activity levels are achieved over the next few years. Nonresidential structures investment is also expected to climb quickly from depressed levels in 1990-91, and 1989 levels of activity are expected to be regained by 1993. For machinery and equipment investment, the weakness in 1991 has been less severe, as manufacturers continue to modernize.

Employment growth in the recovery is expected to be centred in the durable goods manufacturing, construction and services sectors. Nondurable industries are expected to register less output growth which, in tandem with strong productivity gains, will serve to limit employment opportunities in these industries.

More jobs will be created in 1992 across all facets of the economy, except administration, which show exceptional growth in 1991. Over 65% of the jobs created are expected to be in; community, business and personal services and finance, insurance and real estate sectors. In addition, while agriculture held on to employees during the recession, it begins to shed labour in 1993, and continues to do so throughout the remainder of the 1990s. As a consequence of these developments, the overall unemployment rate begins to improve, registering 8.8% in 1992, and eventually falling to 6.7% by 1995. The decline in unemployment rates is somewhat slower than one would normally expect, due to a combination of an increased labour force and less employment.

Long Term Trends - 1996 to 2010

- **Economic Trends.** Ontario's average annual growth of 2.8%, over the 1996 to 2010 period, is below the 4.7% rate projected for the 1991 to 1996 recovery period. Much of this results from slower growth in the U.S. which, like Canada, experiences slower population growth and weak productivity improvements late in the forecast period.

  Growth in Ontario is expected to continue to outpace growth at the national level, reflecting immigration from other provinces in response to job opportunities. In particular, Ontario is expected to be home to over half of all new manufacturing jobs created in Canada, of which more than 60% are expected to be in durable goods production. For the primary sector, excluding agriculture, job creation will continue to be weak.

  As business expands and more people move into the province, additional demands for community, business and personal services can be expected. Over the last 15 years of the forecast, this category accounts for about half of all job creation in the province, which is somewhat higher than that experienced during the boom of the late eighties. The larger population should also keep pressure on housing over the longer term, with starts expected to be greater than 80,000 per year.

  Exhibit 3.5 provides a graphic summary of Base Case growth trends. This and subsequent exhibits show the industrial profile of the scenarios in terms of index numbers based in 1976. This calculation normalizes each industry's output to the same base and the slope of the index values from 1976 to 2011 reflect the cumulative expansion of the sector. Thus sectors with higher index values in 2011 have grown relatively more than the others. This index number based comparison of industry groupings is repeated in each scenarios for various combinations of concepts: high growth versus low growth industries, various aggregations (manufacturing and services), final demand categories (e.g. exports and consumption) and environmental groupings.

The upper panel shows growth in output for industrial groups. In general, the trend for stronger growth in service industries persists across the 1990s. However, the cyclical recovery of manufacturing, from very low levels in 1991 and 1992, provides a significant rebound and temporarily shifts the structure of the economy back towards goods production. The lower panel provides details on the manufacturing industries, showing that several environmentally sensitive sectors have a weaker recovery. Strength in motor vehicle manufacturing is very apparent across the entire period and this is a theme that is repeated in Scenarios 1 and 2.

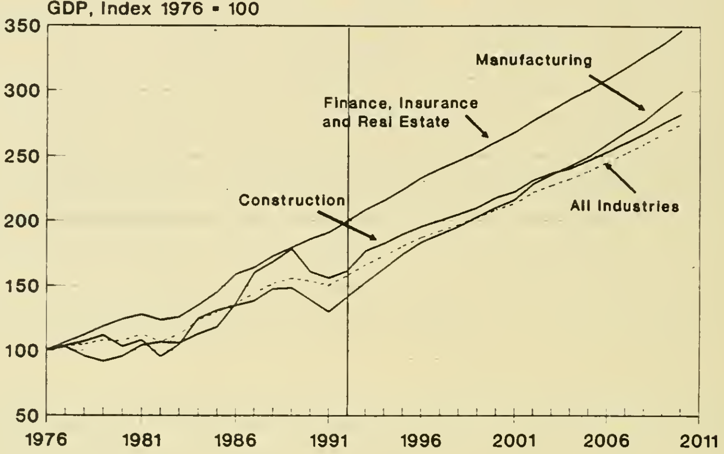
Notice that in the Base Case the total economy in 2010 is 83% larger than in 1991, measured in terms of real G.D.P. This overall expansion is roughly in line with twenty year trends in population growth and moderate improvement in wellbeing (in terms of income or consumption per person). The shocks or changes that will imposed on this base in the next sections are small relative to the basic growth trend. For the overall economy, in 2010, the first scenario raises GDP by 13.6%, less than one fifth of the initial base case expansion. Other scenarios, discussed below, will have similar incremental effects. In fact, no single shock that we considered would alter the expected size of the economy more than say +/- 20%.

Exhibits 3.6, and 3.7 show the same industry data for major sectors but the data are organized by industry shares. Gross Domestic Product and Employment values are recorded and these update the historical detail presented in Chapter 2.

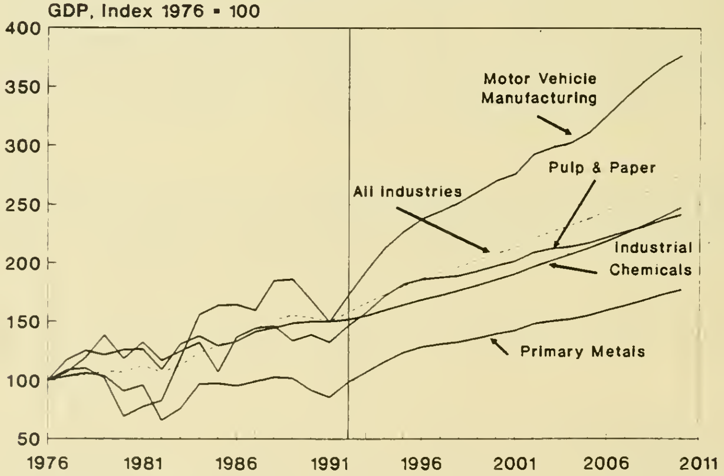
Exhibit 3.5

Base Case - Growth Comparisons

Industry Groups



Manufacturing Industries



Source: History: Statistics Canada,
Forecast: ARA Consulting \ Informetrica

EXHIBIT 3.6
ONTARIO'S INDUSTRIAL STRUCTURE
SECTORAL GDP GROWTH RATES AND RELATIVE SHARES
BASE CASE

	Shares			Growth Rates	
	1992	2000	2010	1992-2000	2000-2010
Agriculture, Fisheries, Forestry, Trapping & Logging:	1.85%	1.72%	1.57%	2.61%	1.87%
Mining:	1.62%	1.66%	1.70%	3.85%	3.07%
Manufacturing:	24.64%	27.76%	29.94%	5.09%	3.59%
Construction:	7.00%	7.15%	7.02%	3.82%	2.62%
Transportation & Storage:	4.31%	4.24%	4.19%	3.35%	2.69%
Communications & Utilities:	5.60%	5.50%	5.41%	3.31%	2.64%
Trade:	12.55%	11.93%	11.42%	2.88%	2.36%
Finance, Insurance & Real Estate:	15.55%	15.39%	15.53%	3.41%	2.89%
Commercial, Business & Personal Services:	21.25%	19.98%	19.10%	2.74%	2.34%
Government:	5.63%	4.66%	4.10%	1.12%	1.50%
TOTAL Ontario G.D.P.:	**159,833.9**	**211,104.7**	**278,383.7**	**3.54%**	**2.81%**

Source: Informetrica Ltd.

EXHIBIT 3.7
ONTARIO'S INDUSTRIAL STRUCTURE
SECTORAL EMPLOYMENT GROWTH RATES AND RELATIVE SHARES
BASE CASE

	Shares			Growth Rates	
	1992	2000	2010	1992-2000	2000-2010
Agriculture, Fisheries, Forestry, Trapping & Logging:	2.53%	2.05%	1.91%	-0.81%	0.55%
Mining:	0.43%	0.39%	0.37%	0.76%	0.56%
Manufacturing:	16.59%	16.47%	15.71%	1.77%	0.78%
Construction:	7.30%	7.57%	7.60%	2.34%	1.29%
Transportation & Storage:	3.90%	4.09%	4.23%	2.49%	1.58%
Communications & Utilities:	2.47%	2.35%	2.19%	1.20%	0.58%
Trade:	21.23%	20.03%	18.73%	1.14%	0.57%
Finance, Insurance & Real Estate:	6.67%	7.19%	7.61%	2.83%	1.82%
Commercial, Business & Personal Services:	33.63%	35.09%	36.85%	2.41%	1.75%
Government:	5.25%	4.77%	4.80%	0.66%	1.33%
TOTAL Ontario Employment:	**5,037.4**	**5,842.6**	**6,615.0**	**1.87%**	**1.25%**

Source: Informetrica Ltd.

- **Environmental Trends.** As the future pattern of industrial activity shifts there will a change in the mix of output. One objective of this study is to measure the implications of these shifts for emissions to the environment and resource use. While this measure will be dealt with more specifically in Chapter 5, we can begin to study this area with a preliminary grouping of industries by their intensity of emissions or resource use. Exhibit 3.8 collects the industries in the model into three groups: resource, air and water and land waste intensity. Industries are assigned to each of these groups if their utilization of resources or emission levels places them in the top 25% of all industries. Ranking are based on the environmental factors that are defined in Chapter 4 and summarized in Exhibits 4.3 through 4.5.

  These three aggregations are graphed in Exhibit 3.9 as growth indexes in comparison with the overall economy. The same industry aggregations will be analyzed in terms of impacts in the scenario discussed below.

  Exhibit 3.9 documents that relatively slower growth of all three types of environmental industry aggregations. Resource intensive industries (principally metal processing industries) grew at well below average rates from 1976 to 1991 and this is projected to continue into the future. The industries that contribute more to land waste (including the large service sectors like community, business and personal services) grew more rapidly that the other industry groups but still lagged the overall expansion of the economy.

  All three groups expanded at below average rates between 1976 and 1991 principally because high growth sectors like finance, insurance and real estate and communications and utilities are missing from most of the calculations. The resource intensive sector grows the least and this is due to a heavy weighting of primary industries. The land waste intensive group grows the most, though less than the economy as a whole. This group is heavily influenced by the large community and business services group where growth is close to the provincial total.

  We will track these groups through the four alternative scenarios.

Exhibit 3.8: Selected Industrial Aggregations by Environmental Focus *

Resource Intensive

- Logging & Forestry Ind.
- Metal Mining Excl. Iron
- Mining - Iron
- Non-metal Mining
- Mining - Coal
- Mining - Crude Petro & Nat Gas
- Mining - Quarry & Sand Pit Ind
- Transportation - Air
- Transportation - Railway
- Transportation - Water
- Transportation - Pipeline
- Utilities - Electric Power
- Utilities - Water & Other
- Trade - Retail
- Primary Textile & Textile
- Wood
- Furniture
- Paper & Allied - Pulp & Paper
- Paper & Allied - Paper Conv
- Printing & Publishing
- Primary Metal - Iron & Steel
- Primary Metal - Non-ferrous
- Trans. Equip. - Ship Building
- Non-Met. Min. - Total
- Non-Met. - Cem. & Clay Prod
- Non-Met. - Glass
- Petrol. & Coal - Total
- Chemicals - Industrial
- Manufactur. - Other Miscl.

Air & Water Waste

- Agriculture & rel. serv.
- Mining - Total Extraction
- Transportation - Air
- Transportation - Water
- Transportation - Pipeline
- Utilities - Electric Power
- Utilities - Water & Other
- Services - Health - Hospitals
- Paper & Allied - Pulp & Paper
- Primary Metal - Iron & Steel
- Primary Metal - Non-ferrous
- Non-Met. Min. - Total
- Petrol. & Coal - Total
- Chemicals - Industrial

Land Waste

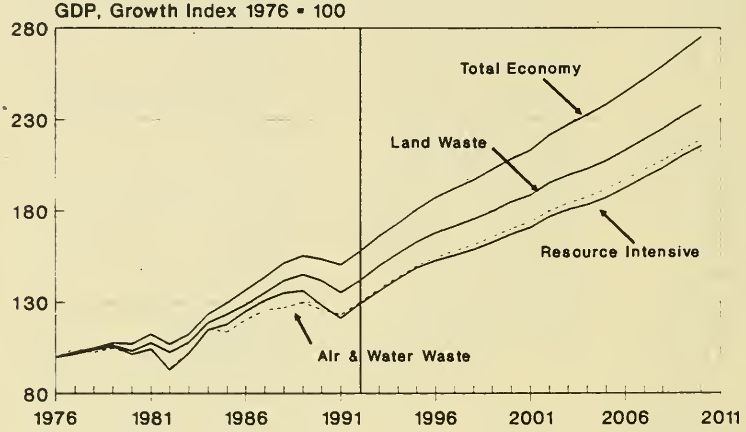
- Agriculture & rel. serv.
- Construction - Total
- Transportation - Total
- Trade - Retail
- Community Business&Pers Serv
- Food Prod - Total
- Rubber
- Primary Textile & Textile
- Wood
- Furniture
- Paper & Allied - Total
- Primary Metal - Total
- Metal Fabric - Total
- Machinery - Total
- Trans. Equip. - Total
- Non-Met. Min. - Total
- Chemicals - Total
- Manufactur. - Other Miscl.

* Industries were chosen according to intensity of resource use and waste production. Those in the medium to high range were included while those in the low range were excluded.

Exhibit 3.9

Selected Industrial Aggregations

By Environmental Focus



Source: ARA Consulting \ Informetrica
See 3.8 for Industry Listings

3.2 Scenario 1 - International Expansion/Stronger Growth

Scenario 1 assumes a very different international economic situation and builds significantly more activity into the period to 2010. Stronger growth involves a different set of demographic and other circumstances in Canada.

Highlights and key assumptions include;

- Strong investment in Europe boosts international economic growth such that output is 20% higher in 2011 with U.S. G.N.P. up 15%.
- Real interest rates are declining by the mid 1990s
- U.S. productivity improves and export sales rise relative to the Base Case
- Resource and basic commodity prices improve relative to the Base Case.
- Export and related industries (e.g. transportation services) grow most rapidly.

In this case (and all others), it is assumed that Canada's immigration policies are set over the long term to accommodate shifting levels of activity and avoid labour surpluses or shortages. Stronger economic growth abroad stimulates exports in Canada and increased immigration is assumed to accommodate increased labour demand. Domestic birth and death rates are unchanged from the Base Case.

Investment in Europe grows steadily to accommodate the larger market between 1992 and 2000 and then European exports begin to expand, increasing their share of international trade.

The improved international climate is due to a smooth integration of Eastern Europe. Capital requirements are low for basic infrastructure and the market grows rapidly as a destination for North American and other exports. The EC and Eastern Europe enter a period of extended growth without inflation. New productive capacity in Europe begins an export drive by 2000.

Real interest rates begin a gradual decline in the 1990s, inflation abates and savings accumulate in many countries.

The gradual elimination of trade barriers continues with the successful completion of the GATT Uruguay round, integration in Europe and North America. Lower trade barriers combine with domestic growth to encourage strong expansion in all bilateral trade links. European currencies appreciate modestly relative to North American currencies.

U.S. productivity improves and export growth continues at 1988-1990 rates and U.S. imports also grow rapidly. Approximately 100 billion (1991 US$) is transferred from U.S. defence spending and most of the workers and resources are deployed in new export activities. This is a massive shift in U.S. economic structure and it is accomplished with little dislocation between 1993 and 2000. The U.S. government and trade deficits are steadily reduced as a percentage of GDP. Real interest rates trend down relative to the highs of the 1980s.

Stronger world growth increases demand for base metals, forest products and energy. Relative prices rise and basic process manufacturing expands.

With the exception of immigration policy, other Canadian policies are left the same as in the base case scenario. However, the generally higher level of exports increase employment, incomes, profits, tax revenues and spending. In this more positive environment there is less need for fiscal restraint and, in some sectors, governments even accumulate surpluses.

Exhibits 3.10 and 3.11 describe the impacts of the increased international activity relative to the base case values. Expanded demand for goods and services is greatest outside North America. The combined output of the G7 countries (excluding Canada) rises by 20.2% by 2010. U.S. economic activity is boosted by 15%. This increased activity raises Canadian sectors in particular exports and business investment. Export led growth boosts manufacturing output and there is a related but smaller impact on consumer spending.

In Ontario the impacts are most pronounced in manufacturing and business where output rises over 15%. Exhibit 3.12 highlights the impacts in the broad industry groups and Exhibits 3.13 and 3.14 review the leading and lagging sectors.

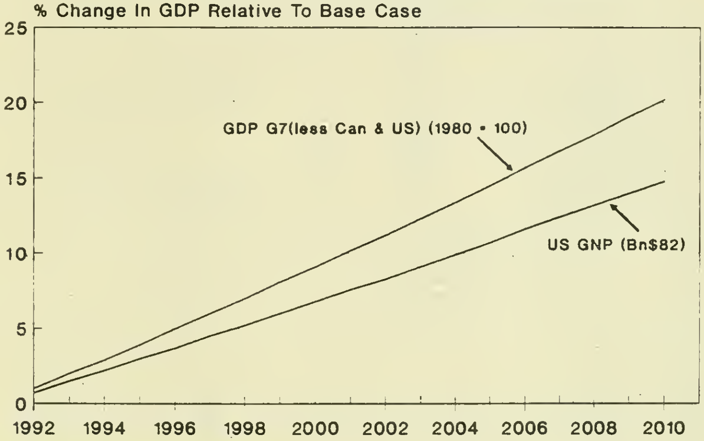
The weaker sectors include a mixture of manufacturing and service industries. Government spending is not increased by much as new revenues are used to reduce the deficit rather than provide new services. A few, key environmentally sensitive sectors also show weak impacts including plastics, chemicals and pulp and paper.

Stronger impacts are recorded in key service sectors - transportation, communication and utilities. Within manufacturing there are notable impacts on transportation equipment and machinery.

Exhibit 3.10

Scenario 1 - International Growth

Key Assumptions: International Indicators

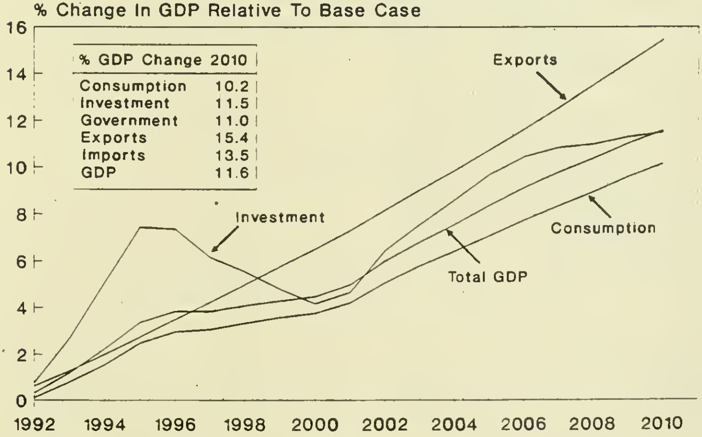


Source: ARA Consulting \ Informetrica

Exhibit 3.11

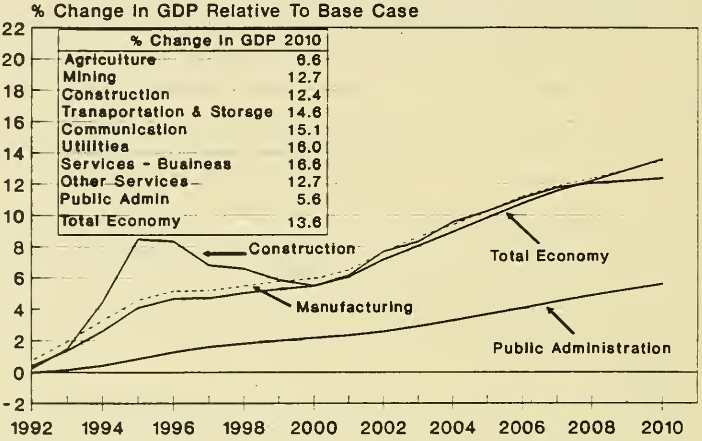
Scenario 1 - International Growth

Key Assumptions: National Factors



Source: ARA Consulting \ Informetrica

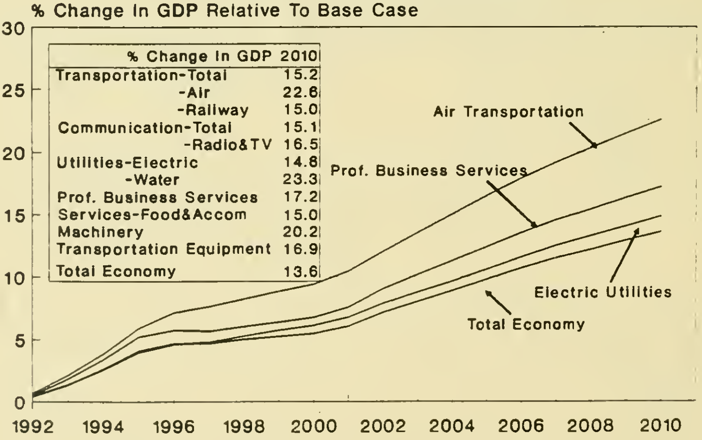
Exhibit 3.12
Scenario 1 - International Growth
Ontario - Industry Groups



% Change In GDP 2010	
Agriculture	6.6
Mining	12.7
Construction	12.4
Transportation & Storage	14.6
Communication	15.1
Utilities	16.0
Services - Business	16.6
Other Services	12.7
Public Admin	5.6
Total Economy	13.6

Source: ARA Consulting \ Informetrica

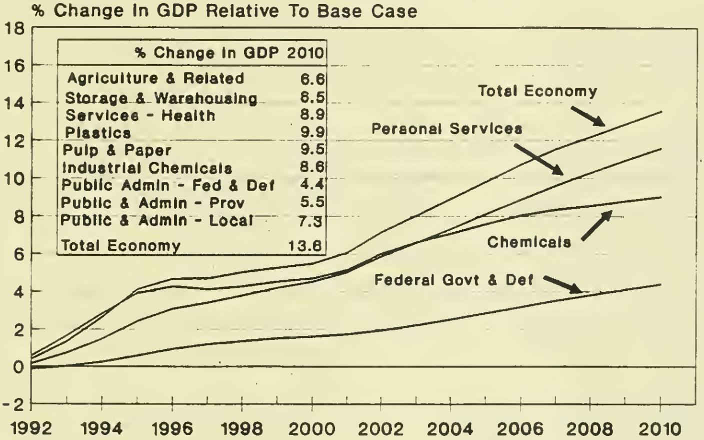
Exhibit 3.13
Scenario 1 - International Growth
Ontario - Strong Industries



% Change In GDP 2010	
Transportation-Total	15.2
-Air	22.6
-Railway	15.0
Communication-Total	15.1
-Radio&TV	16.5
Utilities-Electric	14.6
-Water	23.3
Prof. Business Services	17.2
Services-Food&Accom	15.0
Machinery	20.2
Transportation Equipment	16.9
Total Economy	13.6

Source: ARA Consulting \ Informetrica

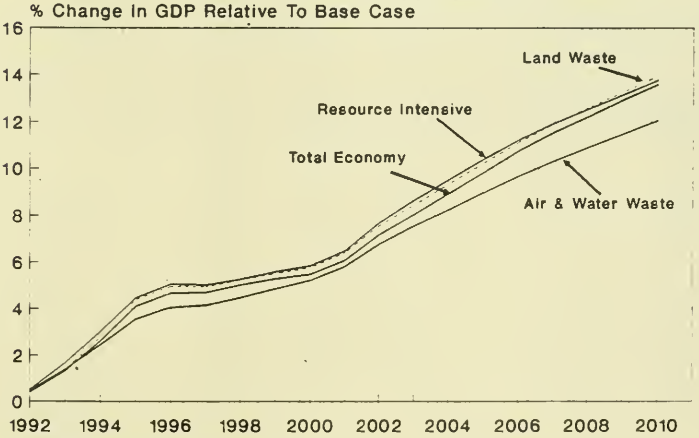
Exhibit 3.14
Scenario 1 - International Growth
Ontario - Weak Industries



% Change In GDP 2010	
Agriculture & Related	6.6
Storage & Warehousing	8.5
Services - Health	8.9
Plastics	9.9
Pulp & Paper	9.5
Industrial Chemicals	8.6
Public Admin - Fed & Def	4.4
Public & Admin - Prov	5.5
Public & Admin - Local	7.3
Total Economy	13.6

Source: ARA Consulting \ Informetrica

Exhibit 3.15
Scenario 1 - International Growth
Environmental Aggregations



Source: ARA Consulting \ Informetrica

These changes seem to have captured the continuing dematerialization of the economy. Relative impacts are less in the case of basic materials but larger in the advanced manufacturing and business sectors. The reflects the trend to more value added type industries.

These changes are small relative to the basic growth trend. For the overall economy, in 2010, the first scenario raises GDP by 13.6%, less than one fifth of the initial base case expansion. Other scenarios, discussed below, will have similar incremental effects.

These results show that it is difficult to impose shocks on the econometric models that create major changes in structure relative to Base Case trends. In Scenario 1, discussed here for example, the massive stimulus provided to global economic growth does not significantly shift the industrial composition of Ontario. Existing markets, technologies and consumer preferences act to distribute employment, capital and spending in roughly the same manner as in the Base Case. This may be a structural feature of the econometric models where fixed behavioral coefficients are assumed and this is discussed further at the end of this Chapter.

However, the data presented in Chapter 2 for the period 1976 to 1991 shows the same structural rigidities. There appears to be considerable structural inertia and on the margin, changes in industrial composition happen slowly. Traditional industrial classifications are used across the forecast period and thus impose a limited view on the structure that emerges in the year 2010. It seems likely that entirely new industries (like environmental protection) may be created over the intervening years and these would not be reflected in the model projections.

Exhibit 3.15 shows the impacts of the increased international demand on the three environmental aggregations. All three groups are very close to the provincial average with resource intensive and land waste industries expanding more than average. The differences, however, are quite small and there does not appear to be a shift towards or away from environmentally sensitive industries.

EXHIBIT 3.16
ONTARIO'S INDUSTRIAL STRUCTURE
SECTORAL GDP GROWTH RATES AND RELATIVE SHARES
SCENARIO 1 - INTERNATIONAL GROWTH

	Shares			Growth Rates	
	1992	2000	2010	1992-2000	2000-2010
Agriculture, Fisheries, Forestry, Trapping & Logging:	1.85%	1.69%	1.49%	3.04%	2.25%
Mining:	1.63%	1.66%	1.69%	4.46%	3.75%
Manufacturing:	24.72%	27.88%	29.92%	5.76%	4.30%
Construction:	6.99%	7.15%	6.95%	4.49%	3.27%
Transportation & Storage:	4.31%	4.27%	4.23%	4.07%	3.48%
Communications & Utilities:	5.60%	5.54%	5.50%	4.04%	3.49%
Trade:	12.56%	11.93%	11.44%	3.52%	3.13%
Finance, Insurance & Real Estate:	15.52%	15.39%	15.70%	4.07%	3.78%
Commercial, Business & Personal Services:	21.22%	19.97%	19.26%	3.39%	3.20%
Government:	5.60%	4.51%	3.81%	1.39%	1.83%
TOTAL ONTARIO G.D.P. $:	**160,454.**	**222,686.**	**316,204.8**	**4.18%**	**3.57%**

Source: Informetrica Ltd.

EXHIBIT 3.17
ONTARIO'S INDUSTRIAL STRUCTURE
SECTORAL EMPLOYMENT GROWTH RATES AND RELATIVE SHARES
SCENARIO 1 - INTERNATIONAL GROWTH

	Shares			Growth Rates	
	1992	2000	2010	1992-2000	2000-2010
Agriculture, Fisheries, Forestry, Trapping & Logging:	2.53%	2.02%	1.82%	-0.43%	0.91%
Mining:	0.43%	0.38%	0.33%	0.77%	0.76%
Manufacturing:	16.62%	16.58%	15.79%	2.39%	1.46%
Construction:	7.29%	7.51%	7.32%	2.80%	1.69%
Transportation & Storage:	3.89%	4.05%	4.05%	2.92%	1.94%
Communications & Utilities:	2.48%	2.36%	2.21%	1.84%	1.27%
Trade:	21.23%	19.96%	18.64%	1.64%	1.26%
Finance, Insurance & Real Estate:	6.66%	7.17%	7.76%	3.37%	2.76%
Commercial, Business & Personal Services:	33.63%	35.29%	37.49%	3.04%	2.57%
Government:	5.23%	4.68%	4.59%	1.01%	1.75%
Total Ontario Employment: ('000s)	**5.048.4**	**6,115.0**	**7,418.8**	**2.42%**	**1.95%**

Source: Informetrica Ltd.

3.3 Scenario 2 - Labour Productivity/Strongest Growth

In this scenario there is a shift in government policies that is designed to overcome the weak growth in labour productivity that has plagued Ontario since the mid 1970s. A major initiative is aimed at education, knowledge intensive industries, infrastructure and business investment in new machinery and equipment. This campaign successfully rebuilds growth in labour productivity to rates similar to the 1960s and 1970s.[26]

Key assumptions and highlights include:

- New government and private capital is focused on improving labour productivity in Scenario 1.
- Easier monetary policy allows interest rates to decline
- Labour productivity is assumed to improve by 0.05% per year
- Employment drops modestly as higher productivity reduces labour demands
- Exports rise and the benefits are passed to foreign creditors
- Environmentally sensitive industries expand relatively less than the rest of the economy.

These developments complement the more positive environment of Scenario 1; using the improved government revenues and corporate profits as the basis for funding the required investments. The focus on labour productivity, however, leads to the elimination of some of the jobs that were created in Scenario 1.

Immigration is reduced in response to rising unemployment as fewer workers are required for the projected level of output. Birth and death rates are the same as in the Base Case.

Monetary policy eases and interest rates drop in response to lower inflation and new management at the Bank of Canada.

Additional national annual spending (delivered through the education system) of 100 million ($1991) is added to tackle the "literacy" issue. This would be sufficient to upgrade 2 million students over the next twenty years (100,000 in the system per year); approximately 1.25 billion ($1991) is added each year to spending on municipal infrastructure and through provincial pension funds into high risk industries; 0.6 billion ($1991) is added each year to upgrade the

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[26] These policy objectives were chosen to reflect (in part) the intentions of the new Ontario Industry Policy Framework. See MITT (1992).

Trans-Canada highway system (a provincial expenditure); corporate taxes are reduced by 1.0 billion ($1991) to spur private research and development spending.

Altogether the policy initiatives described above inject almost 160 billion (1991 $) into the national economy between 1991 and 2010. Approximately 50 billion (1991 $) would be spent in Ontario. This incremental spending represents a larger shock to the economy than the environmental initiatives described in Scenario 3.

Annual labour productivity gains are enhanced by 0.5 per cent each year; these are allocated across all of the business sectors proportionately. That is, the assumed disembodied gains, are input for all service sectors as well as for all goods producers.

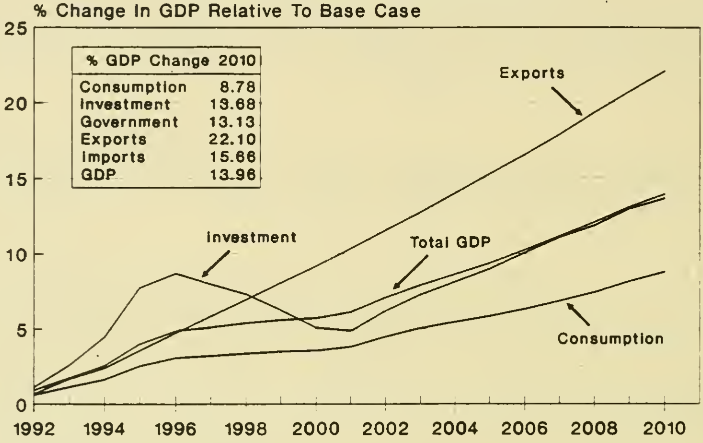
The export sector is the immediate beneficiary of the improved economic conditions. Canada gains an improved share of most markets as price sensitive foreign buyers respond to lower Canadian costs. Profitability rises and real incomes increase as the benefits of the improved conditions are shared among households and corporations. This sharing does not follow the usual pattern, however, as increased activity is concentrated in exports. Rising profits are concentrated in foreign businesses who respond by repatriating earnings. This leakage means that Canadian households are left with relatively little incremental income to spend or save.

Investment rises as a percentage of GDP as new non-residential structures add new capacity. New spending on machinery and equipment, especially in the export sector, is associated with higher labour productivity.

Exhibits 3.18 through 3.21 summarize the impacts of the domestic productivity initiatives following the same format as Scenario 1. At the national level the biggest impacts are in exports as higher productivity improves industrial competitiveness and adds to export volumes. In Ontario's major industry groups there is a recovery in construction activity as investment improves during the recovery phase of the projection. Manufacturing is the main beneficiary among major industries, largely because the output response is most concentrated here. Associated with stronger manufacturing is expanded business services activity in transportation and communication.

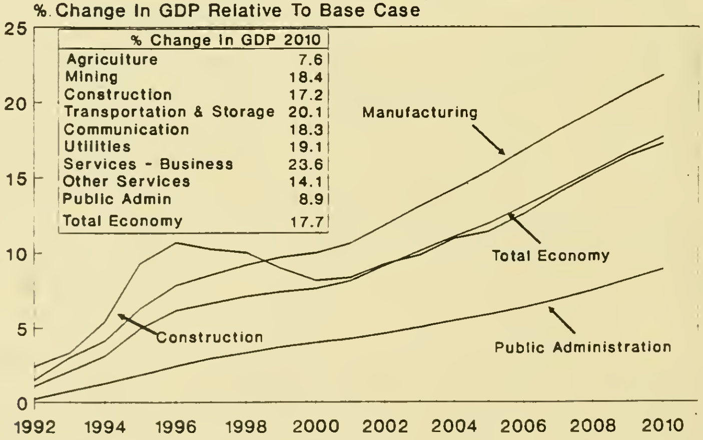
The same pattern of impacts extends across manufacturing as we saw in Scenario 1. Environmentally sensitive manufacturing sectors such as chemicals lag the improved economy while the major gains are in motor vehicle assembly and machinery. One surprise here is the strong performance of the plastics industry - a weaker sector in the Scenario 1.

Exhibit 3.18
Scenario 2 - Productivity Growth
Key Assumptions: National Factors



Source: ARA Consulting \ Informetrica

Exhibit 3.19
Scenario 2 - Productivity Growth
Ontario - Industry Groups

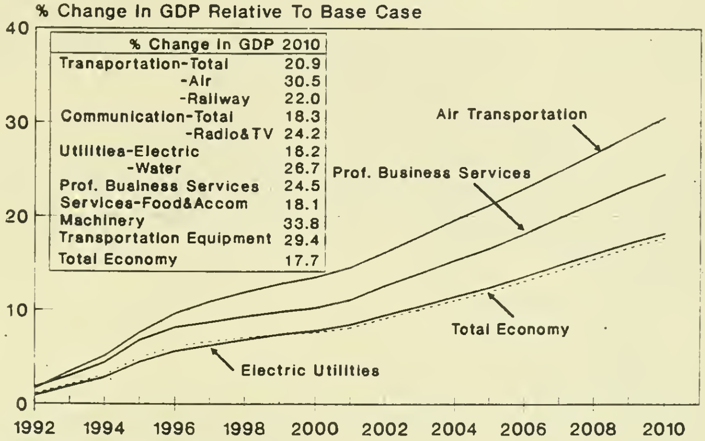


Source: ARA Consulting \ Informetrica

Exhibit 3.20

Scenario 2 - Productivity Growth

Ontario - Strong Industries



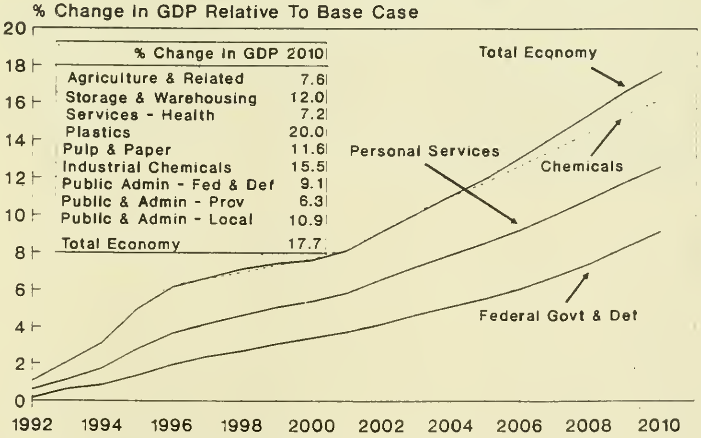
	% Change In GDP 2010
Transportation-Total	20.9
-Air	30.5
-Railway	22.0
Communication-Total	18.3
-Radio&TV	24.2
Utilities-Electric	18.2
-Water	26.7
Prof. Business Services	24.5
Services-Food&Accom	18.1
Machinery	33.8
Transportation Equipment	29.4
Total Economy	17.7

Source: ARA Consulting \ Informetrica

Exhibit 3.21

Scenario 2 - Productivity Growth

Ontario - Weak Industries



	% Change In GDP 2010
Agriculture & Related	7.6
Storage & Warehousing	12.0
Services - Health	7.2
Plastics	20.0
Pulp & Paper	11.6
Industrial Chemicals	15.5
Public Admin - Fed & Def	9.1
Public & Admin - Prov	6.3
Public & Admin - Local	10.9
Total Economy	17.7

Source: ARA Consulting \ Informetrica

This scenario shows little change in the industrial composition of economy. Basically all industries are pushed to slightly higher levels of output with most of the sales in export markets. Domestic multiplier effects are muted by the large leakages of corporate profits to non-residents. Gains in high value sectors such as motor vehicle assembly are distributed to domestic business services but dissipated through imports of new parts. These effects illustrate the inertia of structural shifts due to trade and other market responses. However, as we will see in Chapter 5, this scenario provides new evidence of environmental effects.

Exhibit 3.22 reports on the impacts of the improved labour productivity scenario on the three broad categories of environmentally sensitive industries. All three categories; resource intensive, air and water emissions and land waste groups grow more than the provincial average. These impacts would provide a moderately negative "environmental structural" change to the economy, as described in Chapter 5.

3.4 Scenario 3 - Environmental Initiatives

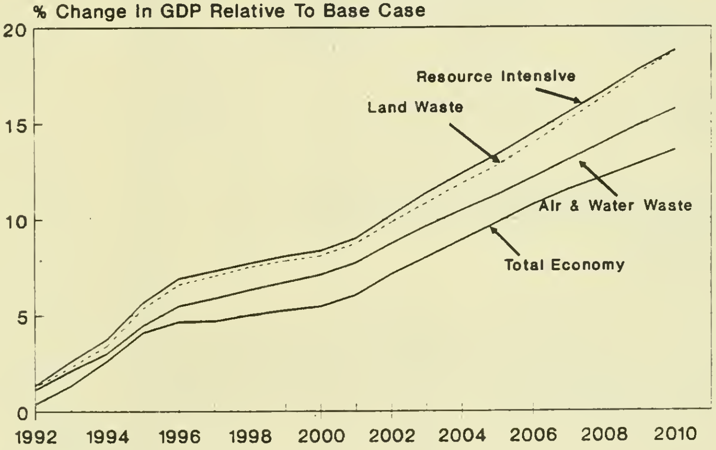
In this scenario the focus turns to environmental issues. Government regulations and capital spending are targeted on environmental protection. Corresponding private sector investment are incorporated. In total, 80 billion ($1991) is invested in environmental protection and resource conservation in Canada between 1992 and 2010, with 30 billion ($1991) in Ontario. This new investment is added to the economic activity in Scenario 2.

Exhibit 3.25 provides a summary of the amount of investment spending in each major economic sector. The Exhibit also shows the general types of emissions that are targeted. Initiatives are aimed at CO_2, SO_2, air pollution, diesel desulphurization and water pollution. The environmental investments in new products and processes are concentrated between 1992 and 2000 and then new spending on operational activities and other types of longer term economic adjustments is concentrated between 2000 and 2010.

Exhibit 3.22

Scenario 2 - Productivity Growth

Environmental Aggregations



Source: ARA Consulting \ Informetrica

EXHIBIT 3.23
ONTARIO'S INDUSTRIAL STRUCTURE
SECTORAL GDP GROWTH RATES AND RELATIVE SHARES
SCENARIO 2 - PRODUCTIVITY GROWTH

		Shares			Growth Rates
	1992	2000	2010	1992-2000	2000-2010
Agriculture, Fisheries, Forestry, Trapping & Logging:	1.85%	1.67%	1.46%	3.09%	2.32%
Mining:	1.63%	1.67%	1.71%	4.67%	3.98%
Manufacturing:	24.74%	28.38%	30.98%	6.15%	4.65%
Construction:	7.09%	7.19%	7.00%	4.53%	3.45%
Transportation & Storage:	4.31%	4.29%	4.28%	4.31%	3.70%
Communications & Utilities:	5.59%	5.52%	5.46%	4.20%	3.60%
Trade:	12.56%	11.93%	11.43%	3.68%	3.29%
Finance, Insurance & Real Estate:	15.46%	15.07%	15.06%	4.02%	3.73%
Commercial, Business & Personal Services:	21.18%	19.76%	18.82%	3.45%	3.23%
Government:	5.58%	4.50%	3.79%	1.58%	1.96%
TOTAL ONTARIO G.D.P. ($ Mill)	**161,567.**	**227,158.**	**327,654.2**	**4.35%**	**3.73%**

Source: Informetrica Ltd.

EXHIBIT 3.24
ONTARIO'S INDUSTRIAL STRUCTURE
SECTORAL EMPLOYMENT GROWTH RATES AND RELATIVE SHARES
SCENARIO 2 - PRODUCTIVITY GROWTH

		Shares			Growth Rates
	1992	2000	2010	1992-2000	2000-2010
Agriculture, Fisheries, Forestry, Trapping & Logging:	2.52%	1.99%	1.76%	-0.81%	0.46%
Mining:	0.43%	0.37%	0.33%	0.40%	0.42%
Manufacturing:	16.62%	16.78%	16.21%	2.30%	1.32%
Construction:	7.32%	7.45%	7.19%	2.41%	1.31%
Transportation & Storage:	3.88%	4.01%	4.01%	2.57%	1.68%
Communications & Utilities:	2.48%	2.35%	2.18%	1.48%	0.95%
Trade:	21.20%	19.81%	18.29%	1.31%	0.86%
Finance, Insurance & Real Estate:	6.64%	7.05%	7.43%	2.94%	2.22%
Commercial, Business & Personal Services:	33.68%	35.38%	37.68%	2.80%	2.32%
Government:	5.23%	4.82%	4.91%	1.14%	1.86%
TOTAL EMPLOYMENT ('000):	**5,072.6**	**6,024.9**	**7,111.7**	**2.17%**	**1.67%**

Source: Informetrica Ltd.

EXHIBIT 3.25
SCENARIO 3 - ENVIRONMENTAL INITIATIVES TOTAL DIRECT INVESTMENT (1991-2010) BY INDUSTRY GROUP AND EMISSIONS TYPE

	EMISSION					
INDUSTRY	**CO_2**	**SO_2**	**AIR**	**DIESEL DESULPHUR**	**WATER/WASTE**	**TOTAL**
	MILLIONS OF 1990 $					
Primary and Mining	100.9	0.0	6.4	0.0	0.0	107.3
Manufacturing	1609.5	619.6	1,032.1	411.8	3970.1	7,643.1
Construction	24.3	0.0	6.4	0.0	0.0	30.7
Transportation & Storage	5116.0	0.0	0.0	0.0	0.0	5,120.1
Communication	0.0	0.0	0.0	0.0	0.0	0.0
Utilities	916.5	1,988.3	252.4	0.0	0.0	3,157.2
Services	3,805.8	0.0	0.0	0.0	0.0	3,805.8
Government	4,999.9	0.0	0.0	0.0	6323.0	11,322.9
Other	1944.3	0.0	0.0	0.0	0.0	1,944.3
Total	18,517.2	2,607.9	1,301.4	411.8	10,293.1	33,131.4

Source: Ontario Ministry of the Environment and Environment Canada - The Green Plan

Key assumptions and highlights include:

- 30 billion ($1991) in spending on environmental initiatives in Ontario;
- Spending is directed to environmental industries;
- Spending is concentrated between 1993 and 2000; and
- Prices, costs and new capital effects continue to affect the economy after 2000.

The primary impact of this scenario is through increased levels of government and business investment in the industries that generate the largest amounts of emissions. Government investment in infrastructure is the biggest effect with new manufacturing, transportation and storage and service investment ranking next. These investments are assumed to alter the capital stock such that emission levels are reduced -- in some cases to levels that are now targeted in Ontario policy. There are several special effects associated with these environmental investments that are not generally associated with normal capital spending,

First, the investment is concentrated in machinery and equipment more than construction. Second, the investment does not raise labour productivity but rather reduces emission intensity. To reflect this employment in the affected industries is maintained at the initial level. Finally, the cost of the investments is recovered through higher prices or taxes and other charges across the entire 1993 to 2011 period. Appendix 2, in particular section A2.2, describes these special effects on the economy in more detail.

These investments include a number of changes that impact consumers and businesses directly. For example, the scenario assumes that government spending on public transit is expanded to encourage restricted use of private vehicles and public roads. The result is a major decline in sales of vehicles, long run demand for gasoline and private travel.

These changes have several effects in the economy. First there is an increase in demand for a wide range of environmental protection products and services. Research by several groups has defined the range of industries and activities that would be impacted by this spending.[27] For example, the construction industry receives a major boost; especially in the design, engineering and heavy contractors sectors. Machinery and equipment manufacturers also experience major new demands.

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[27] See for example the report by Ernst and Young that describes the distribution of environmental protection products and services among major industries.

The concentration of these effects in the relatively short period from 1993 to 2000 means that several industries will be caught short of capacity. This raises an interesting policy question of whether the provincial government should prepare the ground by encouraging the expansion of capacity in these sectors.

In many sectors the need for environmental protection is urgent and significant damage could be averted by short term investment of the type assumed here. These investments are timed to intercept the increased levels of industrial demand and emissions associated with economic growth in scenarios 1 and 2. However, the pace of investment is so rapid that it would not allow Ontario industries to expand the supply of environmental protection services. Imports would fill the gap.

An industrial policy aimed at expanding the capacity of local suppliers for these environmental goods and services would need to begin immediately to expand capacity and it would need to exploit foreign markets to keep the industries working after the Canadian environmental initiative slows in the year 2000.

Exhibits 3.26 through 3.29 describe the impacts of these environmental investments on the economy. In the first years of this scenario (1992 to 2000) the economic impacts are largely higher investment in environmental areas. The demands placed on Ontario industries expand activity beyond the levels of Scenario 2, and in some cases imports rise to accommodate the increased activity. In the later years (2001 to 2010) the impacts are more complex.

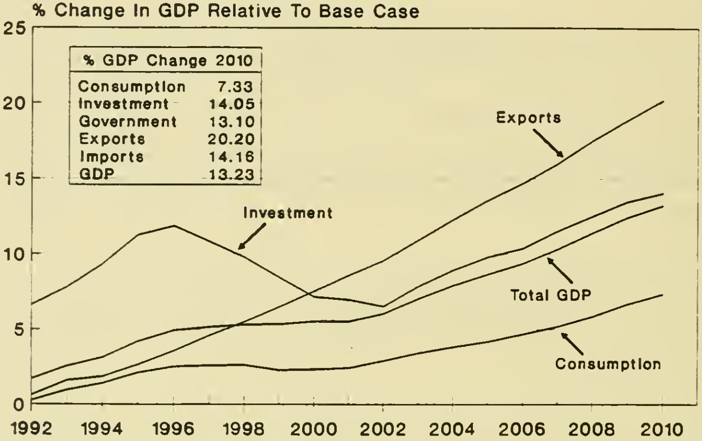
Once the new environmental investments are in place and functioning, the economy has a different operating basis. Higher labour and operating expenses are related to environmental protection systems. These systems deliver less waste and more efficient use of resources. The benefits of reduced emissions and waste are not captured in the current set of economic statistics. Rather, the current manner of measuring activity emphasizes the negative effect of more workers producing the same volume of output. This constitutes a loss of labour productivity. There will be an associated decline in real wages (relative to the Scenario 2 starting point) that will reduce spending and other conventional measures of well being.

Relative to the activity reported in Scenario 2, the simulation results show an overall increase in activity in the early period (1992 to 2000) as investment rises and lower activity in the last ten years. The latter effect is related to lower labour productivity and associated reduced real incomes and spending. Thus in Exhibit 3.31, the final level of Ontario G.D.P. on 2010 is slightly lower than the level reported in Scenario 2.

Exhibit 3.26

Scenario 3 - Environmental Initiatives

Key Assumptions: National Factors



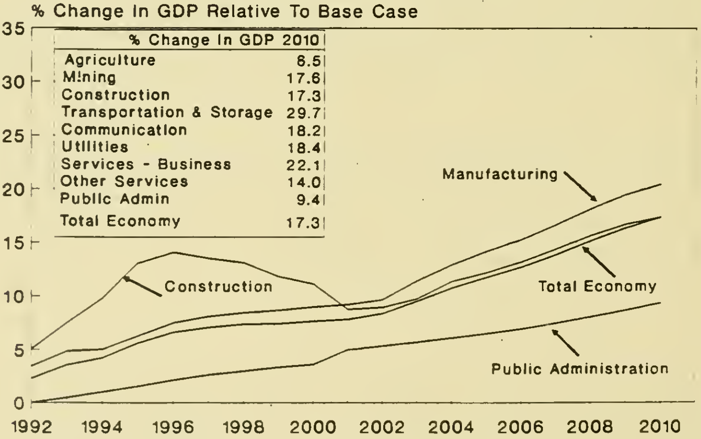
% GDP Change 2010	
Consumption	7.33
Investment	14.05
Government	13.10
Exports	20.20
Imports	14.16
GDP	13.23

Source: ARA Consulting \ Informetrica

Exhibit 3.27

Scenario 3 - Environmental Initiatives

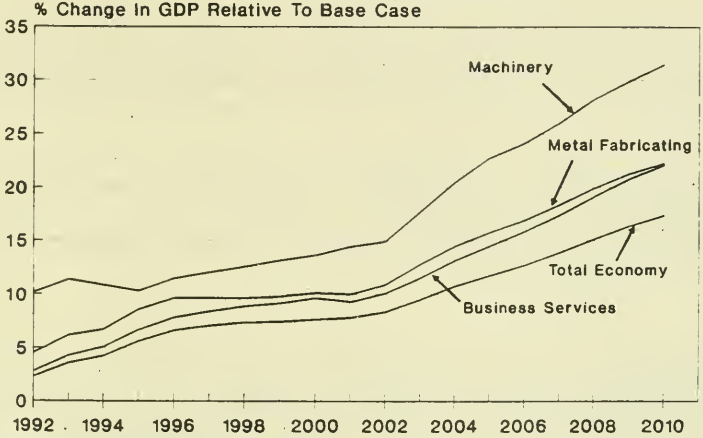
Ontario - Industry Groups



% Change In GDP 2010	
Agriculture	6.5
Mining	17.6
Construction	17.3
Transportation & Storage	29.7
Communication	18.2
Utilities	18.4
Services - Business	22.1
Other Services	14.0
Public Admin	9.4
Total Economy	17.3

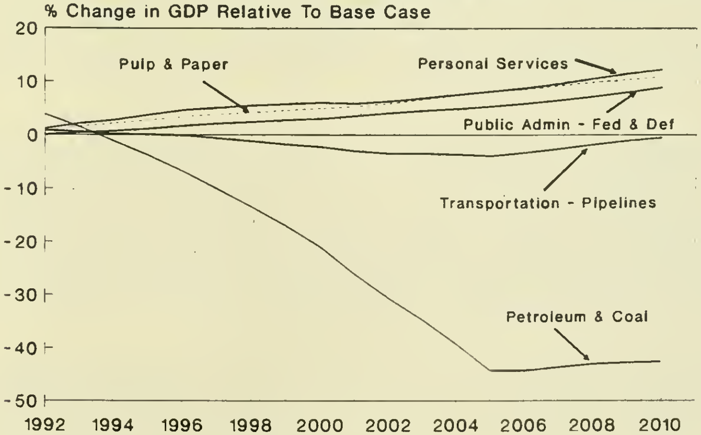
Source: ARA Consulting \ Informetrica

Exhibit 3.28
Scenario 3 - Environmental Initiatives
Ontario - Strong Industries



Source: ARA Consulting \ Informetrica

Exhibit 3.29
Scenario 3 - Environmental Initiatives
Ontario - Weak Industries



Source: ARA Consulting \ Informetrica

Other measures of economic welfare would also appear weaker. For example, Ontario's labour costs would rise relative to other jurisdictions and export sales would be lower. Immigration is initially higher as demand for environmental investment is strong but then is slightly reduced relative to Scenario 2 as employment declines.

The costs of environmental protection will be passed on to consumers and export markets. The models and data that we use here reflect the higher costs to foreigners or consumers but do not capture all the benefits of improved efficiency in resource use and reduced waste.

In Chapter 5, we return to this case and consider the impacts of these investments and the shifts in economic activity on environmental indicators. At the same time we will consider various ways of incorporating some of the changes in technology and efficiency gains that are associated with the 33 billion ($1991) investment.

Exhibits 3.26 through 3.29 review the impacts of the environmental initiatives relative to Base Case. The reader might also refer to the equivalent graphics in Scenarios 1 and 2 to get a sense of the small, but significant difference related to the environmental investments. Output and employment are redistributed by the patterns of environmental investment between 1992 and 2000 and then the operational impacts in the later years. Construction activity is raised in the recovery period (1992-1995) as this sector is among the largest of the environmental protection industries. There is a longer term shift to the public sector as revenues and capital spending are concentrated in government for many of the environmental initiatives. In the later period there is a small but clear shift away from the manufacturing as Ontario's environmental initiatives add to costs and reduce the province's competitive advantage. This loss is marginal, however, as manufacturing activity -- spurred on by the environmental spending -- actually rises above Base Case levels across most of the forecast period.

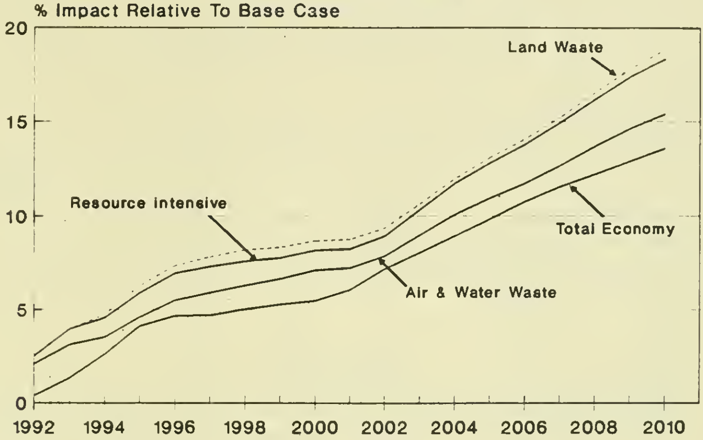
Exhibit 3.28 highlights the industries whose relative share is increased by the investment in environmental programs and infrastructure. Two major beneficiaries are the machinery and business services industries where demand would be increased by the introduction of new technology. Electrical equipment is, similarly, among the stronger sectors. There are a few surprises here as chemical and primary metal production is increased in spite of rigorous programs that impose new costs and operating restrictions on them.

Exhibit 3.29 reviews the industries that are weakened by the environmental initiatives. The biggest negative effect is in petroleum and coal production where added costs and reduced

Exhibit 3.30

Scenario 3 - Environmental Initiatives

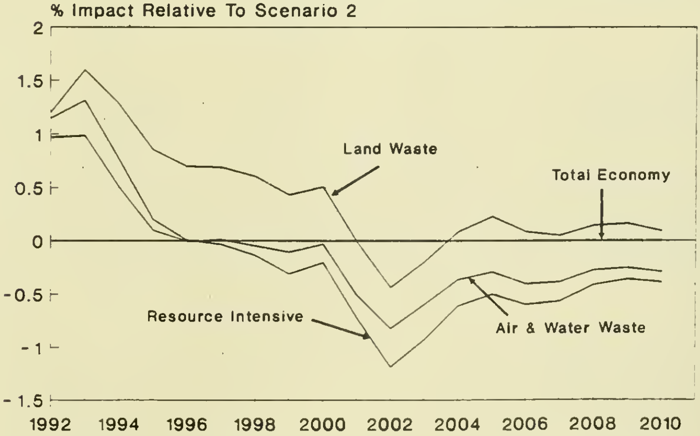
Environment Aggregations



Source: ARA Consulting \ Informetrica

Scenario 3 - Environmental Initiatives

Environment Aggregations



Source: ARA Consulting \ Informetrica

demand for fuel combine to reduce the industries relative importance. Related effects are apparent in pipeline transportation and utility activity.

Exhibit 3.30 shows the impacts on the three environmental aggregations in two formats. The upper panel shows the impacts relative to the Base Case, in the same format as Scenario 1 and 2. In fact, there are only small changes and the differences (compared to the Base Case) are equivalent to Scenario 2. Indeed the 30 billion (1991$) or $1.3 billion each year of new investment is not very large relative to the overall size of the economy. The lower panel of Exhibit 3.30 gives an "exploded view" and considers the comparison of Scenario 3 directly with Scenario 2. The pattern here is consistent with the waste intensive industries expanding (slightly) in the early years, as the investments are made and regulations are put in place. In the later years, the higher costs of operation cause a marginally lower level of operation. Further impacts related to the reduction in emissions and resource use are included in Chapter 5.

EXHIBIT 3.31
SECTORAL GDP GROWTH RATES AND RELATIVE SHARES SCENARIO 3 -ENVIRONMENTAL INITIATIVES

	Shares			Growth Rates	
	1992	2000	2010	1992-2000	2000-2010
Agriculture, Fisheries, Forestry, Trapping & Logging:	1.83%	1.68%	1.48%	3.11%	2.35%
Mining:	1.63%	1.66%	1.71%	4.49%	3.98%
Manufacturing:	24.93%	28.11%	30.73%	5.78%	4.63%
Construction:	7.19%	7.38%	7.02%	4.55%	3.18%
Transportation & Storage:	4.37%	4.62%	4.64%	4.93%	3.73%
Communications & Utilities:	5.59%	5.52%	5.45%	4.03%	3.58%
Trade:	12.57%	11.84%	11.32%	3.43%	3.23%
Finance, Insurance & Real Estate:	15.37%	14.99%	15.02%	3.88%	3.72%
Commercial, Business & Personal Services:	21.03%	19.73%	18.80%	3.37%	3.20%
Government:	5.50%	4.48%	3.82%	1.56%	2.04%
Total Ontario G.D.P. ($ Mill.):	**161,567.**	**227,279.**	**326,676.0**	**4.21%**	**3.69%**

Source: Informetrica Ltd.

EXHIBIT 3.32
SECTORAL GDP GROWTH RATES AND RELATIVE SHARES
SCENARIO 4 -INDUSTRIAL SHIFT

	Shares			Growth Rates	
	1992	2000	2010	1992-2000	2000-2010
Agriculture, Fisheries, Forestry, Trapping & Logging:	1.85%	1.68%	1.46%	2.32%	1.35%
Mining:	1.54%	1.32%	1.05%	1.60%	4.37%
Manufacturing:	24.01%	25.59%	27.01%	4.37%	3.36%
Construction:	7.29%	8.12%	8.57%	4.95%	3.37%
Transportation & Storage:	4.21%	3.91%	3.57%	2.58%	1.90%
Communications & Utilities:	5.67%	5.81%	5.85%	3.87%	2.88%
Trade:	12.54%	11.75%	10.99%	2.70%	2.12%
Finance, Insurance & Real Estate:	15.43%	15.29%	15.44%	3.42%	2.90%
Commercial, Business & Personal Services:	21.72%	21.49%	21.41%	3.40%	2.76%
Government:	5.76%	5.03%	4.64%	1.81%	1.98%
Total Ontario G.D.P. ($ Mill.):	**159,833.9**	**211,104.7**	**278,383.7**	**3.54%**	**2.81%**

Source: Informetrica Ltd.

Impacts on Supplying Industries

Scenario 3 simulates spending 81.2 billion (1991$) on national environmental projects between 1992 and 2000. Ontario investment would rise by 33.1 billion (1991$). Exhibit 3.33 provides a breakdown of the national spending required of industries now impacting the environment.

EXHIBIT 3.33
REQUIRED SPENDING ON ENVIRONMENTAL INITIATIVES NATIONAL DIRECT INVESTMENT BY INDUSTRIES AND CONSUMERS TOTAL SPENDING, 1992 TO 2010

Industry	**Millions of 1990 $**
Petroleum and Natural Gas	1972.9
Other Mining	307.2
Paper and Allied	3659.6
Primary Metals	3022.8
Petroleum and Coal	3330.8
Chemicals	5373.6
Other Manufacturing	2519.2
Total Manufacturing	17906.0
Transportation	13484.3
Utilities	6217.5
Commercial Services	8325.0
Municipal Government	27591.3
All other industries	5449.6
Consumers	5325.5
Total	**81253.8**

This money would be spent on a mix of goods (mostly machinery and building materials), design and construction services. One measure of the impact of the increased spending is the distribution of output requirements within Ontario. Exhibit 3.34 provides a summary.[28]

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[28] Informetrica Ltd. provided a special run of their provincial input-output model to isolate the direct plus indirect impacts of environmental spending specified in Scenario 3. These impacts show the combined requirements in terms of Gross Domestic Product by industry and this is summarized in Exhibit 6.2.

The main industrial beneficiaries of the expanded investment in environmental protection are the construction, professional business services, machinery and electrical equipment sectors. The demands placed on these sectors are significant but not overwhelming. Relative to the expected supply capacity of these sectors, the Scenario 3 investment plans would not increase sales by more that 1 or 2%. The exception here is in the engineering construction sector where peak year activity would add 33% to demands.

EXHIBIT 3.34
IMPACTS ON SUPPLYING INDUSTRIES, SCENARIO 3
DIRECT AND INDIRECT IMPACTS OF ENVIRONMENTAL INITIATIVES
ONTARIO, PERCENT DISTRIBUTION

Industry	Millions 1991$	Percent Distribution
Metal Fabricating	203	2.9
Machinery	204	2.9
Electrical Equipment	496	7.3
Engineering Construction	1576	23.2
Transportation	290	4.4
Utilities	154	2.2
Wholesale Trade	568	8.4
Professional Business Services	412	6.2
All Other Businesses	2887	42.5
Total	**6790**	**100.0**

Statistics, Models and Environmental Restructuring

Scenario 3 introduces the concept of environmental restructuring by simulating the impacts of a major program of investment in emissions reductions. As the comments in the above section and in Appendix 2 suggest, this type of structural change represents a challenge to the conventional tools of economics. In general, conclusions in this report are limited by the statistics and models that provide the basic input. It is important to recognize the limits of the tools and theories that we use to study the economy and the environment.

Social values and political ideologies are deeply planted in perceptions of economic performance. Since the industrial revolution society has pursued economic growth based on the exploitation of natural resources. This social preference found its way into traditional economics. Current economic statistics are grounded in the economics of Keynes. This view places demand not supply as the controlling factor. Thus, what we want to consume (not what we can supply) provides the benchmark for economic performance. Econometric models are often based on this concept.

There have been attempts to include the supply capabilities of the economy into economic models used for policy analysis. During the 1970s this work gained momentum and gradually gained greater acceptance. Theorists tried to include a representation of the physical limits to growth.[29] The energy crisis in the middle of the 1970s forced a critical review of this approach, but the basic statistics and models are still built on a demand driven view of the economy. Recent contributions by Daly and Cobb, Nordhaus and Tobin, Zolotas and work at the O.E.C.D. will likely lead to new measures that better capture the role of emissions and waste in the economic process as well as resource use.

One core principal in the current system is that the market provides the most reliable measure of value. This view avoids the most important principal of sustainable development - that market prices are not properly valuing the contribution of non-renewable natural resources.[30]

Economic success is measured in growth in GDP; a market-based measure of aggregate demands and incomes. Productivity (currently regarded as a very important measure of performance) is measured as output (GDP) per worker - no role for non-renewable resources is included. These priorities and principals are built into the statistics and models that guide this research. The models extrapolate these values by estimating historical behavioral relationships (consumer preferences and business investment decisions) from this data set.

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[29] See the discussion of Herman Daly "For the Common Good"(1993), Georgescu-Roegen "The Entropy Law and Economic Process"(1971) and The Club of Rome in Chapter 2. These approaches will likely lead to a new set of economic statistics that will reflect the positive effects of reduced emissions or resource use.

[30] The Ontario Round Table on Environment and Economy provides an excellent summary of the basic concepts of sustainable development. See Ontario Round Table on the Environment and Economy, (1990).

The very process of creating the econometric models binds together the historical behaviour of consumers, governments and businesses with the structural views imbedded in the statistics. The data and theory are combined with regression analysis that seeks out average relationships (or elasticities) that reflect thirty or more years of history. Thus, if the most stable behaviour that is consistent with theory, was observed between (say) 1950 and 1970 these years would become the dominant influence on the projections for 1991 to 2010. This creates the risk that consumer spending (on say motor vehicles) will be projected based on social values that predate environmental awareness.

Similarly production relationships that link labour and capital might reflect technology that is now well out of date. The relationships (literally equations) that describe exports and imports tend to extrapolate the pattern and growth of trade from the distant past. These biases are a serious limitation in a study that is looking at the influence of truly new policies and attitudes on economic structure. However, it is important to reflect on the stability of long term economic relationships that are included in the data and models. Overriding these features on the basis of new expectations about the future may overlook the role of well established preferences that might prevail in the future.

The results of scenarios 1 through 3 reflect the role of trade, price effects and established behaviour in the models and data that we use and these limit the extent of independent structural change. These effects have reduced the extent to which the industrial composition has changed in each scenario. This stability in industrial composition, given significant structural shocks, may be an accurate reflection of a modern economy. However, it frustrates analysis of a basic question underlying this research. Would a major shift in the industrial composition of the Ontario economy have an impact on the amount and composition of environmental indicators? In order to more completely investigate this option, we have created a fourth scenario that is discussed below.

3.5 Scenario 4 - The Impacts of Industrial Composition

The Base Case and the three scenarios described above have simulated the effects of the structural change which would occur in the Ontario economy under various assumptions. In spite of significant shocks these scenarios did not alter the overall industrial composition of the economy very much. This can be seen as the natural consequence of trade and investment linkages with larger industrial economies that are assumed in this analysis to retain the same composition. In this section we bypass the economic models that seem to include structural inertia and construct a more distinct view of changes to Ontario's industry in the year 2010.

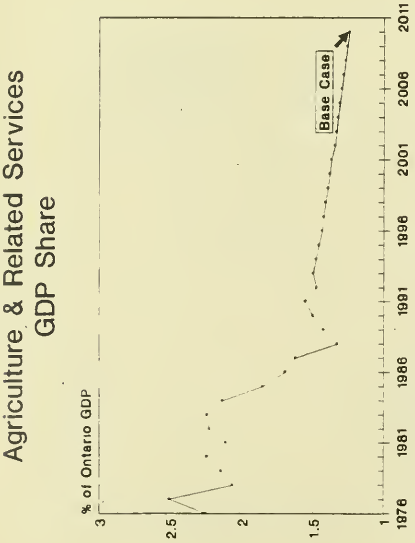
Key assumptions and highlights include:

- The overall level of real G.D.P. is held the same as in the Base Case, only the distribution of output among industries is changed.
- Major shifts in the industrial composition of the Ontario economy with services gaining and primary goods production losing.
- Metal mining, pulp and paper, primary metals and non-metallic minerals and petroleum and coal production all are reduced by between 40 and 50% by 2010.
- Personal and business services, public administration, electrical equipment, machinery and communications gain share and are 20% larger than in the Base Case by the year 2010.
- Environmental impacts are skewed with emissions to air and water reduced relative to the Base Case. Higher shares for the service sector create relatively more waste to land.
- Even with the shifts in industrial shares all sectors produce more in 2010 than in 1991.

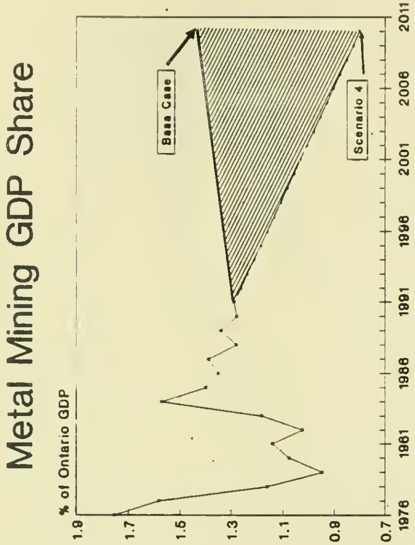
There are no background assumptions about policy or national economic changes to guide the new industrial composition. Instead, this scenario imposes new shares that redistribute the industrial composition of the Base Case projection. Changes in the shares for some 25 industries were imposed on the projection. Patterns were chosen to reflect past trends in shares and the apparent consequences of the deindustrialization of the economy.

Exhibit 3.35 contains a series of graphics portraying the changing GDP shares of 28 Ontario industries used to develop Scenario 4. These shifts in industrial shares are described again in Chapter 5 as the most important source of "environmental restructuring". In some cases this scenario imposes a specific decline in share and the ideas behind these declines are set out below. Where shares increase, the scenario was constructed by a simple rule that allocated all the "lost" GDP to a prescribed set of mostly service industries. The rationale for selecting these gaining industries is also described below.

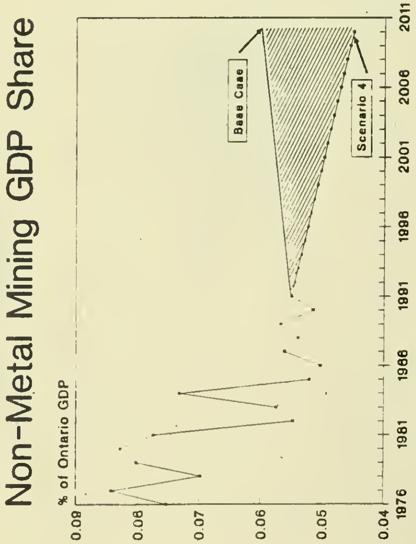
It is important to emphasize that the changes included here are not derived from simulating models of current markets or government programs. Events projected by the econometric models suggest a very different industrial composition in the next twenty years. The composition included here would be created by new industrial processes and policies that



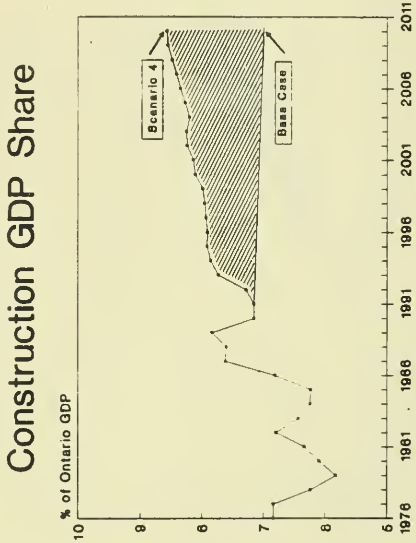
Agriculture & Related Services GDP Share



Metal Mining GDP Share



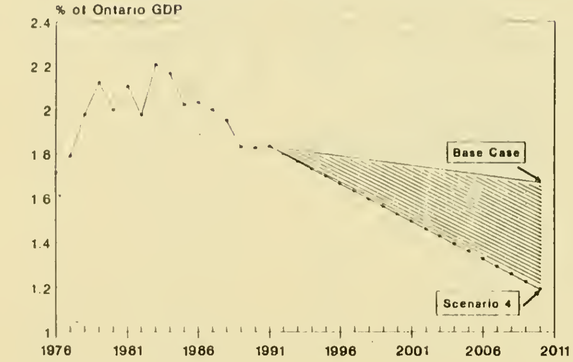
Non-Metal Mining GDP Share



Construction GDP Share

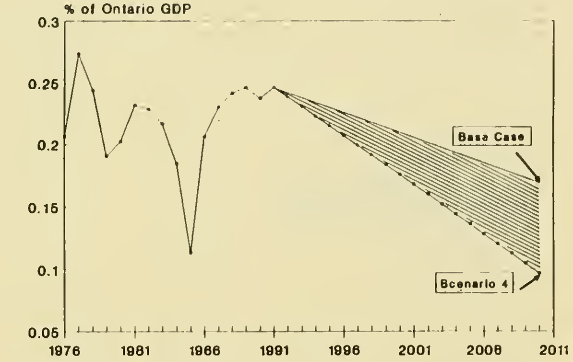
Source ARA Consulting / Informetrica

Chemicals GDP Share



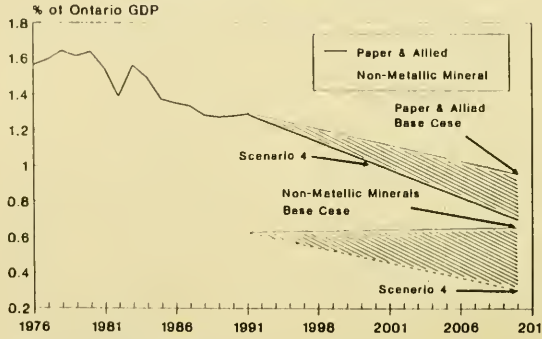
Source ARA Consulting / Informetrica

Petrol & Coal GDP Share



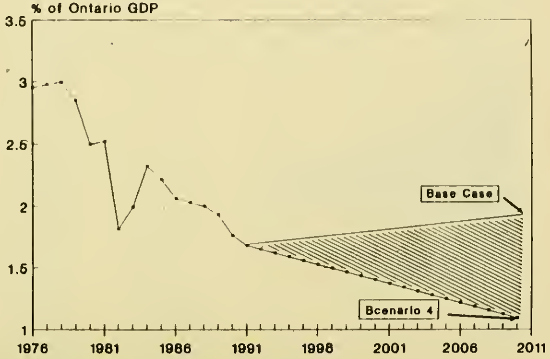
Source: ARA Consulting / Informetrica

Paper & Allied Industries
Non-Metal Minerals



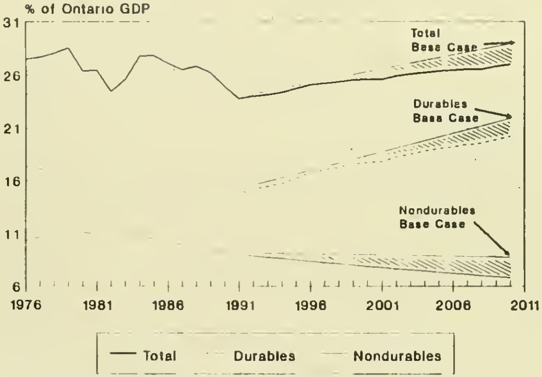
Source ARA Consulting \ Informetrica

Primary Metal GDP Share



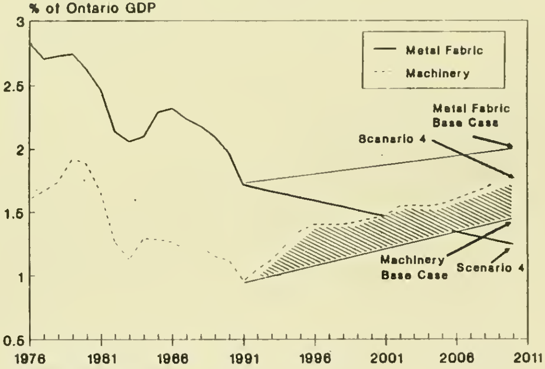
Source: ARA Consulting / Informetrica

Manufacturing



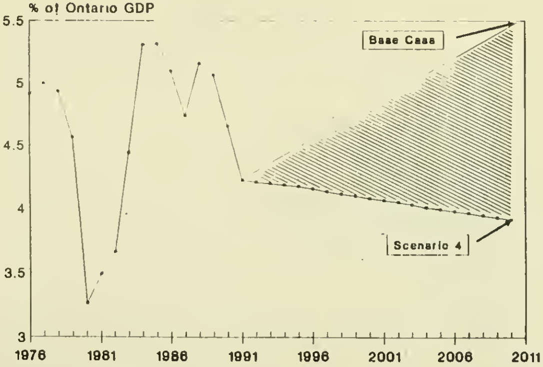
Source: ARA Consulting / Informetrica

Metal Fabric & Machinery



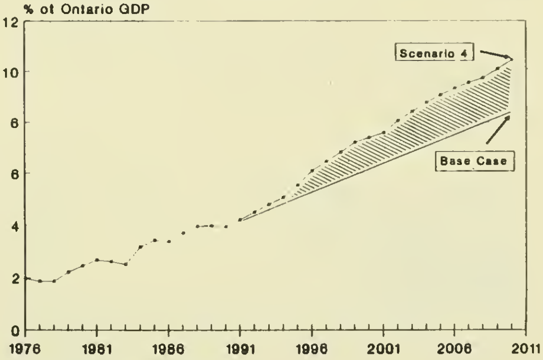
Source: ARA Consulting / Informetrica

Transportation Equipment GDP Share



Source: ARA Consulting / Informatrica

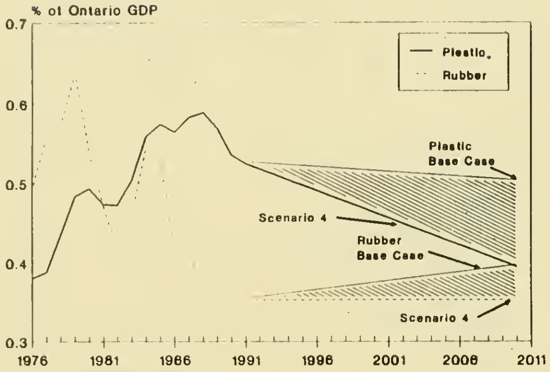
Electrical Equipment GDP Share



Source: ARA Consulting / Informetrica

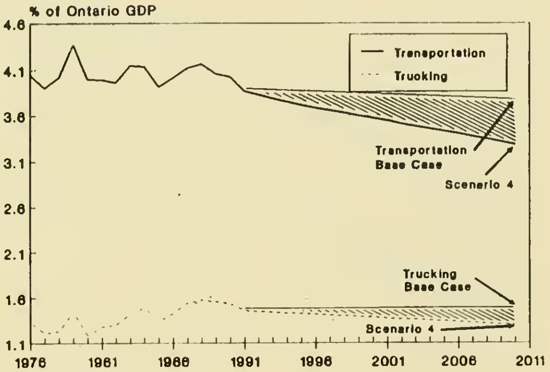
Exhibit 3.35 (cont'd)

Plastic & Rubber



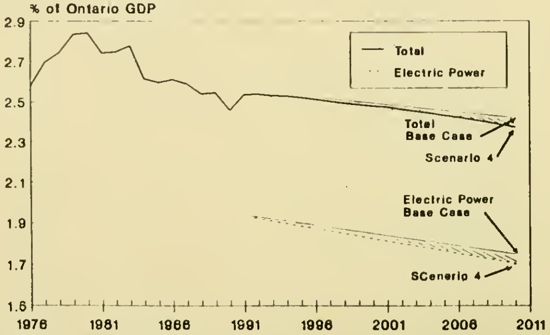
Source ARA Consulting / Informetrica

Transportation & Trucking



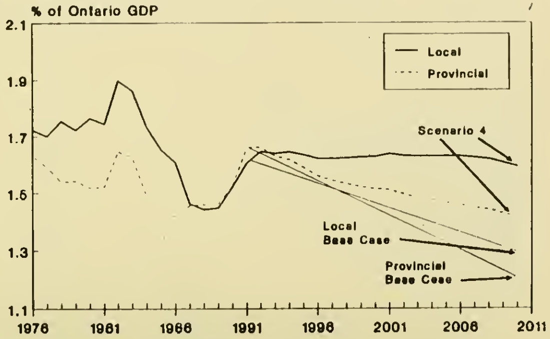
Source: ARA Consulting / Informetrica

Utilities
Total & Electric Power



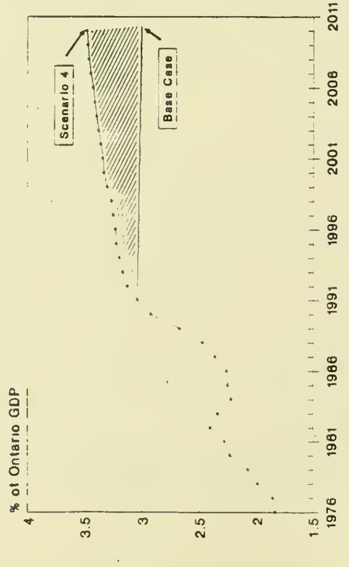
Source ARA Consulting \ Informetrica

Public Administration
Local & Provincial



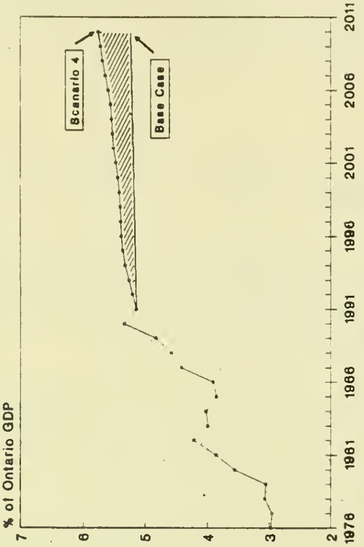
Source: ARA Consulting / Informetrica

Communication Industry GDP Share



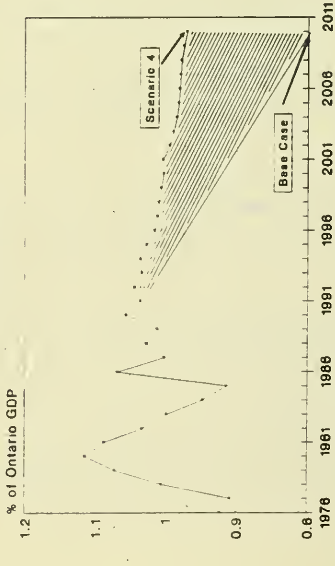
Source. ARA Consulting / Informetrica

Business Services GDP Share



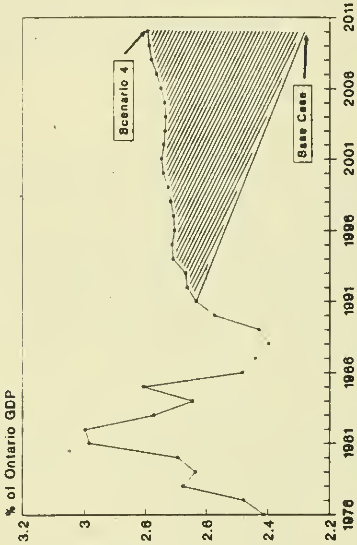
Source: ARA Consulting / Informetrica

Recreation & Amusement Services GDP Share



Source ARA Consulting \ Informetrica

Personal Services GDP Share



Source: ARA Consulting / Informetrica

deliberately discourage raw material production and heavy manufacturing while allowing the traditional expansion of the services sectors. The Scenario 4 trends for industry shares, shown in Exhibit 3.35, generally extend the experience of the past fifteen years.

Rationale for Industry Shifts

Changes in industrial shares imposed in the scenario are described below, starting with the primary sectors and concluding with the service industries.

Primary industries are all assumed to continue on the downward path that has been established since the 1970s. A greater share loss is imposed than in the Base Case to capture the increased use of recycling and the extended dematerialization of the international economy.

There is a conspicuous increase in construction as this sector is a major participant in environmental protection. Engineering design, site restoration, retrofitting and other activities will add demand for construction services.

There are both increasing and decreasing trends in manufacturing. Most non-durable sectors (chemicals, petroleum and coal, paper and allied and rubber and plastics) will continue to decline in importance, including the chemicals sector where the production of raw, basic chemicals will be replaced by recycling or conservation higher in the production chain. Similar changes affect paper, rubber and plastics - although the latter shows limited declines due to its importance in the growing construction industry. There is a strongly negative effect in petroleum and coal production as both fuels impose environmental damage.

Among the durables sectors (metal fabricating, machinery, transportation equipment and electrical equipment) there are strongly positive trends in machinery and electrical equipment. The latter has become a very large segment of manufacturing and gains here are an important positive contribution. This reflects the continuing introduction of new technologies. A moderate decline in transportation equipment has been imposed to capture the spreading effects of increased public transportation and higher costs for private vehicle operation. Metal-related industries all show declines as recycling replaces the production of raw materials.

These effects in manufacturing balance out to a decline in the share of non-durables and a modest increase in durables. Total manufacturing gradually recovers share until, in 2010, it has regained the 1986 contribution to total GDP.

The diminished role of industrial production has the effect of reducing the importance of transportation and utilities. These shifts are offset by rising importance of communication and other business services. Government's role is boosted by the assumed importance of regulation and public sector involvement in the management of the economy.

Results

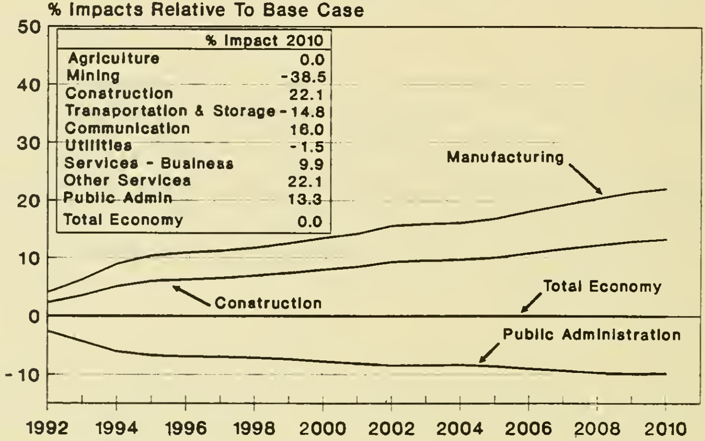
Exhibits 3.36 and 3.37 view the results of this scenario in the same manner as the earlier scenarios. Most of the industries with declining shares face reductions in GDP of between 15 and 30%, relative to the Base Case, by 2010. Major reductions are in metal mining, with a 44% decline, pulp and paper production (down 40%), primary metals and non-metallic minerals (down 43 and 54% respectively). Petroleum and coal production is down 45% relative to the Base Case. Other environmentally sensitive sectors such as chemicals and plastics are down significantly.

The loss of output is allocated back to service industries (principally personal and business services, public administration, electrical equipment, machinery and communications). Each of the industries is about 20% larger than in the Base Case by the year 2010.

Would this shift in industry composition reduce the absolute level of emissions and resource use in 2010 relative to 1991? This would depend partly on the extent to which production technologies change to use resources more efficiently or lower emissions. These factors are considered in Chapter 5. If there were no changes in technology it would be necessary to reduce the level of output over the twenty years. Would the shifts in industry shares included here reduce industrial production? In virtually every industry production in 2010 is higher than in 1991. Even the industries with the largest loss of share continue to increase output -- though it is at a much reduced rate of growth. This is because the economy has expanded by 80% in the intervening twenty years. Structural shifts are not sufficient to overcome the general momentum of economic expansion.

A final Exhibit 3.38, summarizes the results in terms of the three environmental aggregations: resource use, air and water emissions and land wastes. All three categories are reduced with land waste intensive industries reduced by less than 5%. This confirms the pattern noted earlier. The broader scope of the industries (and consumer groups) sending waste to land -- basically solid wastes to land fill -- makes this environmental problem least sensitive to restructuring.

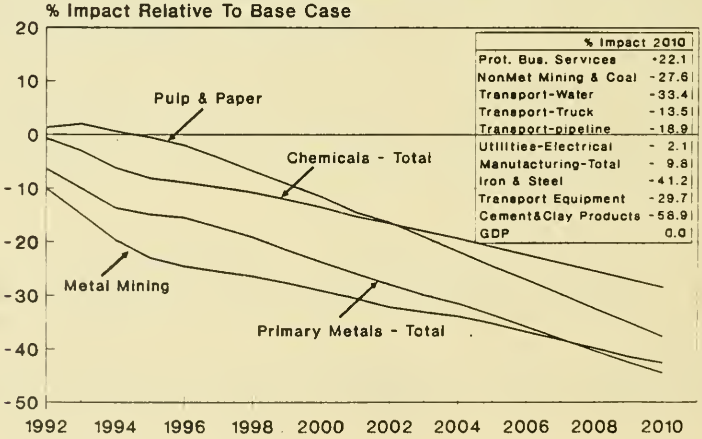
Exhibit 3.36
Scenario 4 - Industrial Shift
Ontario - Industry Groups



	% Impact 2010
Agriculture	0.0
Mining	-38.5
Construction	22.1
Transportation & Storage	-14.8
Communication	16.0
Utilities	-1.5
Services - Business	9.9
Other Services	22.1
Public Admin	13.3
Total Economy	0.0

Source: ARA Consulting \ Informetrica

Exhibit 3.37
Scenario 4 - Industrial Shift
Ontario - Weak Industries



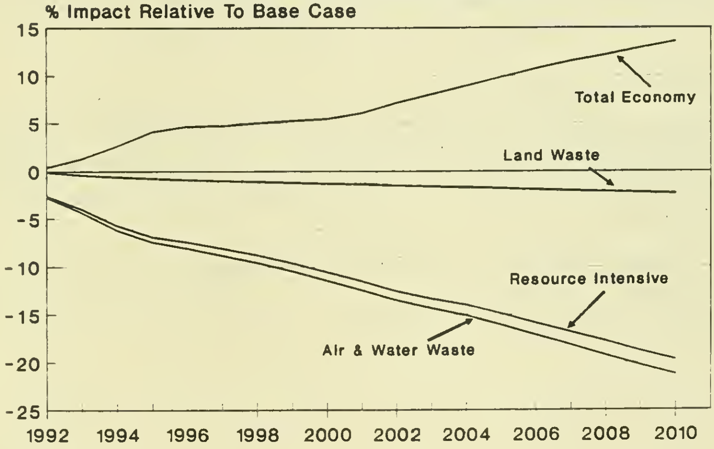
	% Impact 2010
Prof. Bus. Services	-22.1
NonMet Mining & Coal	-27.6
Transport-Water	-33.4
Transport-Truck	-13.5
Transport-pipeline	-18.9
Utilities-Electrical	- 2.1
Manufacturing-Total	- 9.8
Iron & Steel	-41.2
Transport Equipment	-29.7
Cement&Clay Products	-58.9
GDP	0.0

Source: ARA Consulting \ Informetrica

Exhibit 3.38

Scenario 4 - Industrial Shift

Environmental Aggregations



Source: ARA Consulting \ Informetrica

3.6 Summary

This chapter has presented a series of four scenarios that represent variations on a Base Case projection for Ontario. The results for the first three scenarios show a remarkable structural inertia in the Ontario economy. Changing foreign economic growth, domestic policies and environmental programs all serve to shift industrial activity only on the margin. A more direct manipulation of industrial structure imposed shifts between 1992 and 2011 that extended the trends to larger service and smaller primary industries in the 1976 to 1991 period. The largest impact that can be derived in any of these scenarios altered output in broad industry groups by perhaps 20% and individual industries by up to 40%. Structural changes rarely serve to actually force a reduction in the overall level of output in particular industries.

To this point the study has focused on the output of Ontario's industries. This is just one part of the question. Next we must consider how this output is linked to emissions to the environment and the use of resources. The next chapters turn to the construction and application of environmental indicators that will interpret the impact of the economic results presented here.

4.0 ENVIRONMENTAL INDICATORS

The ability to examine the environmental consequences of economic structural change depends on the set of indicators used to describe the environmental profile of the Province. The analysis for this study also depends on quantitatively linking environmental indicators to economic activity. In this chapter, a set of environmental indicators are defined, available data described, and values and economy-environment linkages developed.

The development of indicators and economy/environment linkages is an ambitious task and, given the state of knowledge and data for environmental impacts, runs into inevitable constraints. These limitations and caveats on the indicators and linkages are also discussed in this chapter.

The chapter is structured as follows. Section 4.1 sets out the framework for the indicators and linkages. Section 4.2 describes the data used, and Section 4.3 presents the specific indicators used in this study. This chapter is supported by an appendix covering detailed estimates of waste generation and economy-environment linkages in the form of emission use factors. These latter factors are constructed as the ratio of resource use or emission to Gross Domestic Product (1981$) in each industry. Identification of environmental indicators was based on a number of different sources, including the data bases available (see Appendix 1), Environment Canada (1991), OECD (1991), Statistics Canada (1991), Faeth (1991) and discussions within the study team.

4.1 Framework

4.1.1 Structure of the Environmental Indicators

Three categories of indicators are included under the general heading of "environmental indicators":

- indicators of waste generation;
- indicators of resource use; and
- indicators of energy use.

Indicators of Waste Generation

Indicators of waste generation address the emission of solid wastes, air pollutants and water effluents that result from economic activity. These indicators can be defined as *point of emission* indicators, *stress response* indicators, or *"quality of life"* indicators.

Point of emission indicators refer to the dispersal of pollutants into the environment. They are related directly to industrial production or economic activity. Examples include sulphur dioxide emissions, discharges of toxic effluents, and generation of industrial solid waste. Point of emission indicators describe the stresses on environmental resources from waste generation.

Stress response or ambient indicators move away from sources to describe the state of the environment. Point of emission and ambient indicators can overlap, but for most pollutants, the distinction is important. As suggested by the name, stress response indicators take into account the stress on the environment (i.e., the emissions as described by point of emission indicators) as well as the environment's ability to respond to that stress -- the sensitivity of environmental resources at risk and the "buffering capacity" to absorb the stress. Stress response or ambient indicators would include, for example, indicators of river quality or lake acidity.

Finally, "quality of life" indicators translate stress response indicators into measures of socio-economic importance. Such indicators would include damage to natural resources (e.g., changes in crop yields) or implications for human health (e.g., increased risk of cataracts).

Stress response indicators and/or quality of life indicators tend to provide a more appropriate assessment of environmental and socio-economic consequences of economic growth and structural change. However, their development requires a considerable amount of data, much of which is not readily available. They are also predicated on relationships between emissions, environmental sensitivities and buffering capacity that are complex, controversial, and often quite poorly understood. Given these problems and the uncertainties they would introduce into the analysis, this study focuses exclusively on point of emission indicators.

Point of emission indicators are developed for: (i) air; (ii) water; (iii) land. Air indicators provide a measure of pollutants emitted to the atmosphere, such as CO_2, SO_2, NO_X, etc. Environmental concerns related to water cover both quality and use, although indicators of water use fall into the realm of resource use, which is discussed below. Indicators of waste generation, show the quantity of conventional, non-conventional, or toxic waste or effluent discharged into water courses. The third category of waste generation indicators focuses on land as a recipient of industrial and municipal solid waste.

Indicators of Resource Use

Use of natural resources is considered part of the environmental profile of the Province for the purposes of this study. For convenience, we have grouped resource use indicators as follows: (i) renewable resources (excluding energy); (ii) non-renewable resources (excluding energy); (iii) water use; (iv) wildlife; and (v) land use. Waste generation indicators characterize the production of wastes and resource use indicators characterize the consumption of resources. Resource use indicators have an added dimension as consumption should be compared to some benchmark. In the case of renewable resources, the benchmark is a measure of sustainable yield; for non-renewable resources, the benchmark is a measure of remaining reserves.

Ideally, renewable resource indicators involve forestry resources, fisheries resources, water resources, and hydroelectric potential. Non-renewable resources cover base metals and industrial minerals. (Energy-related indicators are dealt with under the third category of indicators). The indicators of water use can be defined in terms of gross industrial withdrawals, industrial water consumption, municipal water consumption, and some measure of available water resources.

Land use indicators are grouped as agricultural and non-agricultural. The specific indicators of non-agricultural land use would ideally include:

- land area disturbed for mining;
- land area used for industrial activity;
- land area used for urban expansion;
- land area used for landfills; and
- loss of wetlands and prime agricultural lands.

For agriculture, a preferred set of indicators would include:

- ratios of areas of cropland to areas of improved land;
- fertilizer use per hectare;
- pesticide and herbicide use per hectare;
- soil degradation (including erosion risk and nutrient depletion);
- area in fallow;

- tillage practices; and
- land under irrigation.

Indicators of wildlife would include the number of species at risk, the extent of species diversity, and number of protected areas or wildlife reserves.

Indicators of Energy Use

Energy resources have two environmental dimensions; resource use and waste generation. Under the latter point, energy is a primary source of many of the pollutants which are a policy concern, including SO_2, CO_2, NO_X, local environmental impacts, and the generation of radioactive wastes. Because of the diverse environmental impacts associated with energy use, this indicator is often used as a composite description of environmental stress.

Energy use is included as an indicator in this study because of its usefulness as a composite indicator and to provide a basis on which to compare with other jurisdictions. However, the waste generation aspects of the indicator are not additional to other waste generation indicators. For example, SO_2, CO_2, and NO_X emissions from energy use are included in the waste generation indicators described above. In many respects, then, energy use must be treated as a separate (not additional) indicator of waste generation.

The geographic scope of this study raises a second qualification to the energy use indicator. Specifically, some of the waste impacts associated with energy use in Ontario will not occur in the Province. For example, methane leaks (and, consequently, methane emissions) associated with the production of natural gas used by Ontario industry occur in Alberta, not in Ontario. Although Ontario is "responsible" for those methane emissions, they are not included in this study. The exclusion of extra-provincial environmental impacts, therefore, underestimates the environmental implications of economic growth and structural change in Ontario related to energy use.

The jurisdictional issue also affects the interpretation of energy use from a resource use perspective. Much of Ontario's energy sources, such as coal, petroleum, and natural gas, are supplied from outside the province. In consultation with the Ministry of Environment, it was decided that depletion of out-of-Province resources is not strictly part of the study. Data on energy reserves, therefore, have not been compiled.[31] However, energy resources that are sourced in Ontario (e.g., hydroelectricity) are considered in the long list of indicators.

4.1.2 Environment/Economy Linkages

All environmental indicators discussed above are expressed in physical units (e.g., tonnes, cubic metres). In order to evaluate the importance of changes in economic structure on the Province's environmental and resource use profile, physical measurements of emissions and resource use must be linked to economic activity; that is, environment/economy linkages must be specified.

Ideally, one would specify these relationships in terms of sector and sub-sector specific production functions which would account for recycling relationships, the implementation of abatement technologies, substitution between industrial processes and technologies, etc. However, the data collection effort required for such an exercise is beyond the scope of this study and would likely encounter significant constraints. Instead, we have related resource use and waste generation to an aggregate measure of economic activity.

Specifically, the environment/economy linkages are defined on real Gross Domestic Product (GDP), a measure of the value added generated within the Province. For waste generation, the physical units of emissions are divided by GDP to derive emission factors. Resource use factors are calculated by dividing the physical units of resource use by GDP. Energy use factors are similarly defined (i.e., terrajoules per million dollars of GDP).

In some cases, linking environmental indicators to economic activity posed significant complexities. The linkages between the status of wildlife and economic activity, for example, are largely indirect. Wildlife is affected by habitat loss or degradation that is the result of a multitude of contaminants and economic and non-economic activities occurring over an indeterminate period of time. The linkages between wildlife and general economic activity could be modelled as changes in the levels of the number of threatened species as a function of industrial output. However, the data required to properly specify the time lags between industrial activity and wildlife impacts, and the numerous other factors which contribute to the levels of threatened wildlife, would be considerable and subject to misspecification, possibly resulting in misleading conclusions.

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[31] Assessment of the "sustainability" of energy use in Ontario is further complicated by the fact that energy use would have to be compared to national or even international reserves of energy resources, a task well beyond the scope of this study.

Linking land use to economic activity is similarly complicated by indirect linkages. For example, agricultural activity, while tied to the quantity and quality of available land, is largely determined by supply and demand factors for agricultural products -- while variations in domestic population and industrial demand may have an impact on domestic agricultural products, shifts in export demand will have a much greater impact. As a further example, it is unlikely that there is a simple, linear relationship between economic activity (such as construction) and land use, especially in areas where urban in-fill and reconstruction may intensify land use but not necessarily use more land.

In short, the methodology selected for this study -- relating waste generation and resource use to GDP -- is inappropriate for certain environmental indicators. This is partly due to the use of GDP (Gross Domestic Product) as the only comprehensive measure of economic activity across all sectors. GDP is a simple measure of some inputs into the economic process. It does not explain how these inputs are linked to fixed stocks of non-renewable resources such as land. Because of this deficiency some of these indicators are treated qualitatively and are discussed in terms of general trends and direction of impacts.[32]

Based on the environmental indicators discussed in Section 4.1.1 above, the methodology to estimate the environmental implications of different economic scenarios consists of three steps:

1) Calculate emission or resource use factors as total emissions or resource use in a given year divided by GDP or population in the same year.
2) Forecast GDP based on structural assumptions discussed above.
3) Calculate resulting environmental indicators as the forecast GDP (or population) times the emission or resource use factor.

4.1.3 Properties of Environmental Indicators and Environment/Economy Linkages

A number of properties and qualifications to the environmental indicators, linkages, and methodology are discussed below.

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[32] For some indicators, we have calculated emission factors or resource use factors as a function of population rather than GDP. This approach is more appropriate for such indicators as municipal waste generation and municipal water use.

a) Coverage of Key Industries/Sectors

The methodology and data used in this study allow complete coverage of all Standard Industrial Classifications (SIC) at the two or three-digit levels. Therefore, the economic coverage is comprehensive.

Not all industries/sectors are covered by comprehensive waste generation data. For example, data on water discharges are available for only six industries (iron and steel, chemicals, metal mining, pulp and paper, petroleum refining, sewage treatment). Data on particulate matter releases are available for ten industrial sectors, excluding, for example, construction and quarry and sandpit mining. However, efforts to collect emissions data have captured the most important sources and this makes it likely that key industries are covered.

There is, similarly, restricted industrial coverage for resource use indicators. All primary industries are included in the economic analysis. However, the availability of resource use factors is limited by: (i) information on some specifics of resource use (e.g., pesticide use); and (ii) the ability to define linkages between economic activity and environmental indicators, as discussed above.

b) Scientific Validity and Data Reliability

One of the criteria for the development of environmental indicators and environment/economy linkages was the scientific validity of the indicators and data reliability. Issues related to the reliability of the economic data were discussed in Section 3.4. Here, we address the validity and data reliability for environmental indicators.

Selection and development of waste generation indicators were based largely on the work of the Ontario Ministry of Environment. All indicators capture emissions that are recognized by the Ministry as pollutants, and most are the subject of environmental policy. Data for waste generation indicators are drawn exclusively from the Ministry reports and sources. The major source was the Environmental Database currently being constructed by VHB Research and Consulting under a separate contract with the Ministry. Because this database was not comprehensive (i.e., did not include data on all indicators), emissions information was supplemented by other Ontario Ministry of Environment publications and previous consultant reports commissioned by the Ministry. Specific sources are identified in Section 4.2.

Data for resource use indicators was drawn either from Statistics Canada or Ontario publications (e.g., Fertilizer Institute, Ontario Ministry of Natural Resources). Again, specific sources are noted below. No original data collection was undertaken in this study.

A number of problems were encountered with the data. First, as discussed above, emissions data are not always available for all SIC codes. Also some data based on monitoring information noted that certain industrial participants had not reported and, therefore, total emissions were likely underestimated.

A number of difficulties arose out of the format of available data. Some data were collected in a manner which was not amenable to the analysis: the data were not reported by SIC code or were reported for a geographic area inconsistent with the provincial scope or only at a national level. As a consequence, the attribution of waste to the Province or to particular SIC code was virtually impossible. When data were reported by category of industrial activity, the reporting units were often inconsistent. Some data were reported on the basis on 1960 SIC codes, while other were reported on the basis of 1970 or 1980 SIC codes. Hence, a certain level of detail was lost in aggregation in an attempt to develop a uniform reporting structure. In other cases, emissions data were not reported by SIC code at all, in which case the study team allocated emissions to what appeared to be the most appropriate SIC codes.

Very little time series data exist for waste generation by category of economic activity. In most instances, values are only available for one year. The lack of time series data had two implications. First, it precluded a historical analysis of waste generation and the past sustainability of economic activity in the province. Second, the use of a single year in developing emission factors injects uncertainty since it cannot be verified that the single year value is truly representative; there is no basis on which to verify that the resulting waste generation estimate is not a "blip".

Notwithstanding these data problems, the environmental indicators do provide coverage of major industries and sectors and the most important waste generators. The lack of time series data will improve over time, as will source coverage. Problems related to format could be mitigated in the future through a stronger focus on standardization of sources (e.g., based on SIC codes).

c) Aggregation and Comparability

At the outset of this study, some consideration was given to aggregating individual environmental indicators and developing a method by which, for example, the "sustainability" of pulp and paper discharges of dioxins and furans could be compared with utility-related SO_2 emissions. The indicators used in this analysis embody some aggregation. For example, water discharges are aggregated into three categories: conventionals, non-conventionals, and toxics; these aggregations abstract from the individual pollutants discharged. Greenhouse gases have also been aggregated into CO_2 equivalents and industrial and municipal wastes have been aggregated across waste types (i.e., the indicator is the volume of waste, irrespective of whether it is paper, plastic, or metals). In the air emissions category, point and area sources have been aggregated by pollutant. These aggregations create a manageable set of 14 waste indicators plus seven resource and energy use indicators.

The issue of comparability calls for development of a method by which to trade-off or compare one environmental impact with another. Empirical information on which to base these trade-offs is scant. More importantly, philosophical issues cast doubt on the appropriateness of making such trade-offs. Hence, we have restricted the analysis to the presentation of the 21 indicators, leaving aside questions of trade-offs.

d) Technological Change

Emission factors developed for this study are a snapshot in time of available technologies. They are not varied over time and, therefore, do not take into consideration general technological change. The reason for static emission factors is the lack of time series data on waste generation. As indicated above, much of the environmental data relates to one year only. Most of this data is for a year some time between 1985 and 1988. Constructing an indicator and emission factor based on 1985 data and using it to forecast waste generation or resource use to the year 2010 implicitly assumes that technology does not change over the intervening 25-year period. Nor is industry-wide, engineering-type information available on which to measure broad shifts in environmental-related technology. This means we have no basis for measuring the extent to which general technological change would allow a decline in emission factors and, hence, level of indicators, over time.

However, the limitation posed by static technology does not render the analysis invalid as long as the focus remains on comparing the same environmental indicators across economic scenarios, and not across years within a single scenario. In comparing across scenarios, one assumes that technological change occurs uniformly in each scenario and, when comparing one scenario to another, the general technological change aspect cancels out. Consequently, differences in waste levels or resources used across scenarios are largely a function of different rates of economic growth and different economic structures.

The empirical value of comparing emissions across years in a single scenario, on the other hand, is highly limited because emissions are based on an unrealistic assumption of zero technological change either in resource extraction and use or in environmental protection technologies. Thus, the environmental indicators projected to the year 2010 in this analysis are used almost exclusively to generate estimates of the differential impact *of the various scenarios* on the use of environmental resources, rather than projections of future levels of waste generation and resource use.

There is one exception to the assumption of no technological change: in Scenario 3, emission factors are manually manipulated to reflect the impact of the introduction of abatement equipment and technology. Hence, Scenario 3 embodies technological change driven by, and specifically associated with, environmental regulation. However, Scenario 3 does resemble all other scenarios in that general technological change (i.e., apart from that driven by environmental regulation) is absent.

One advantage to the environmental indicators calculated here is that they can be updated as more data becomes available. This would include adding annual data for more recent years for the existing indicators as well as creating new indicators for industries and emissions or resource uses not covered in this work.

4.2 Derived Set of Indicators

Exhibit 4.1 presents the list of environmental indicators derived for this study. The derived indicators are a subset of a longer list developed from the framework principles discussed above. In addition to the derived set of indicators, the long list includes those indicators listed in Exhibit 4.2. The indicators in Exhibit 4.2 were excluded from the analysis for one of three major reasons:

- data were unavailable or available only in an inappropriate form;
- inability to link the environmental indicator with indicators of economic activity selected for this study (i.e., GDP, population); or
- the indicator was covered by another indicator.

Some of the excluded indicators, such as wildlife and agricultural indicators, are discussed qualitatively. Quantitative treatment of these specific indicators and assessment of the impact of economic structure on other environmental indicators are left to future research efforts.

The environmental indicators selected for this study (see Exhibit 4.1) overlap, but are generally more comprehensive than the preliminary set of environmental indicators developed by the OECD (OECD, 1991). All air emission indicators used by the OECD (with the exception of CFC's) are included in this study. In addition, this study examines CO, PM and N_2O. The OECD set of indicators provides for two measures of river quality: dissolved oxygen and nitrate concentration. By contrast, this study focuses on point of emission indicators for water quality covered by discharges of conventional, non-conventional, and toxic effluents. The OECD indicator of population served by waste water treatment plants is not included in this study because of the inability to link this indicator with economic activity measures. Land use change indicators identified by the OECD are not included in this study for reasons listed in Exhibit 4.2 (see agriculture and land).

In terms of other categories of indicators, this study captures a much broader range of resource use indicators (e.g., roundwood production, mineral extraction) and opts for measures of water use rather than gross water withdrawals. Indicators of energy use are consistent across both studies.

With these general comments and context in mind, the following section describes the indicators that have been developed for analysis and the data sources used in their construction.

Exhibit 4.1: Selected Environmental Indicators

Indicators of Waste Generation			
Air	SO_2 (point and area source)	CO_2	tonnes/yr
	NO_x (point and area source)	N_2O	tonnes/yr
	VOC (point and area source)	CH_4	tonnes/yr
	PM (point and area source)	CO	tonnes/yr
Water	Conventionals		kilograms/yr
	Non-conventionals		kilograms/yr
	Toxics		kilograms/yr
Land	Industrial/commercial/institutional solid waste - wood		tonnes/yr
	Industrial/commercial/institutional solid waste - total		tonnes/yr
	Residential solid waste		tonnes/yr

Indicators of Resource Use		
	Consumption	**Resource Availability**
Water	Industrial/institutional water use	
	Commercial water use	
	Residential water use	
Minerals	Mineral production	Mineral reserves
Agriculture	Fertilizer use	
Forest Resources	Roundwood production	Mean annual increment

Indicators of Energy Use
Energy Consumption (final demand)

Exhibit 4.2 - Environmental Indicators Excluded from Analysis

	Indicator	Reason for Exclusion
Indicators of Waste Generation		
Air	CFC	To be phased out over study period by regulation.
Water	TKN, BOD, COD, TOC Population served by waste water treatment plants	Covered by other indicators. Inability to link to economic activity indicators used in this study:
Land	Solid waste recycling rates Hazardous wastes Land used for landfill	Inappropriate format. Data available only in highly desegregated form not suitable for this analysis. Inappropriate format.
Indicators of Resource Use		
Water	Water Resources	Lack of data.
Agriculture	Farmland area Organic content of soil CLI land classification Pesticide and herbicide use Erosion risk and degradation Area in fallow Tillage practices Land under irrigation Improved farmland	Lack of data; inappropriate format Inability to link to indicators of economic activity used in study.
Forestry	Area in old growth forests Forest product waste Area lost to fire	Inability to link to economic activity indicators. Covered by other indicator. Inability to link to economic activity indicators.
Fishing	Total catch Sustainable yield or proxies (e.g., yield per unit effort)	Inability to link to economic activity indicators.
Wildlife	Number endangered, threatened or vulnerable species	Inability to link to economic activity indicators.
Land	Protected areas Class 1 farmland development Other land development Stock of Class I land Area disturbed by mining Loss of wetlands	Inability to link to economic activity indicators.
Indicators of Energy Use		
Developed hydro capacity as a percent of potential energy supply		Inability to link to economic activity indicators

4.2.1 Indicators of Waste Generation

Air

Indicators of wastes emitted to the air relate to both point and area-based emissions. Both area and point emission indicators have been constructed for PM, SO_2, NO_X, VOC, and CO. The data relating to point source emissions were gathered from files provided by VHB Research and Consulting (1991), the Ontario Ministry of the Environment (June, 1991) and reports published by Senes Consultants Limited (January, 1992). The coverage of point sources by economic sector is quite comprehensive; data are available for most sectors at a 3-digit SIC level for 1985. Data relating to area-based emissions are reported for the years 1986 and 1987. However, the data were not explicitly associated with particular SIC codes; and emissions were allocated to SIC codes by the study team; the bulk of the area-based emissions were attributed to the service sectors of the economy, in particular transportation. The source for area-based emissions data is the *Fast Reference Document* published by the Ontario Ministry of the Environment (June, 1991).

Water

The emission indicators which relate to water quality are defined for industrial discharges in three aggregations:

- conventional contaminants (e.g., TSS, oil and grease, DOC, sulphide);
- non-conventional contaminants (e.g., ammonia, phenolics, cyanide); and
- toxic contaminants (e.g. mercury, lead, zinc, aluminum, copper, vinyl chloride).

Discharges are reported for six major sectors covering time periods from 1988 to 1991. The source for these indicators was 1988 to 1990 MISA monitoring data supplied by the Ontario Ministry of the Environment.

Land

As indicated above, this category of indicators is concerned with land as a recipient of wastes. The indicators relate to industrial, commercial and institutional (IC & I) and residential solid waste (RSW) generation. Both categories are aggregated across waste types. IC & I waste is aggregated across nine waste types (OCC, office paper, other paper, glass, plastics, organics, metals, tires, and other). Wood wastes are treated separately. Data for IC & I solid waste are available for 25 categories of economic activity (generally at the 2-digit SIC code level) and were taken from files complied by CH_2M Hill Research for the year 1989.

Residential solid waste is also aggregated across waste types. is based on waste generation for the year 1989, and was derived from CH_2M Hill Engineering Ltd. In the case of residential solid waste, the environment/economy linkage (emission factor) is expressed as waste generation per capita rather than waste generation per GDP.

4.2.2 Indicators of Resource Use

Water Use

The indicators of water use are defined in terms of industrial and municipal water use. With respect to industrial water use, net industrial use has been selected as the indicator, although gross industrial water withdrawals is relevant and could be used in addition to net consumption. Non-thermal and thermal water use have been aggregated. The industrial water use data, drawn from the Environmental Database (VHB Research and Consulting) covers about 75-85% of industrial water use and has detailed SIC disaggregations. The data are for the year 1986.

Municipal water use has been expressed in terms of residential and commercial water use. Data were provided from the Environmental Database and are for the year 1989. The resource use factor for commercial water use is expressed in terms of GDP; the resource use factor for municipal water use is based on population (i.e., cubic metres per person).

Non-renewable resources

Mineral extraction is the only indicator that falls under non-renewable resources in this study. Mineral resource use indicators are broken down for metals, non-metals, and structural materials. Production volume data for 30 mineral/base metal types are drawn from the *Ontario Mineral Score* for the year 1988.

Renewable Resources

Two sectors are covered under renewable resources: agriculture and forestry. The only resource use indicator derived for agriculture is fertilizer use. The indicator is based on 1985 data from the Fertilizer Institute of Ontario (Memorandum, November 8, 1990). The resource use factor is calculated as fertilizer use per million dollars of agricultural GDP. It should be recognized that fertilizer use is a highly indirect measure of environmental stress; the impact of fertilizer use varies considerably by location and application. Furthermore, the assumption of constant technology and fertilizer use (per GDP) is particularly restrictive in this instance.

The forestry resource use indicator is roundwood production; the environment/economy linkage is roundwood production in cubic metres per GDP in the forestry/logging sector. Roundwood production covers softwoods and hardwoods, logs and boltes, pulpwood, other roundwood, and fuel wood. Data are taken from Statistics Canada Catalogue 25-201.

4.2.3 Indicators of Energy Use

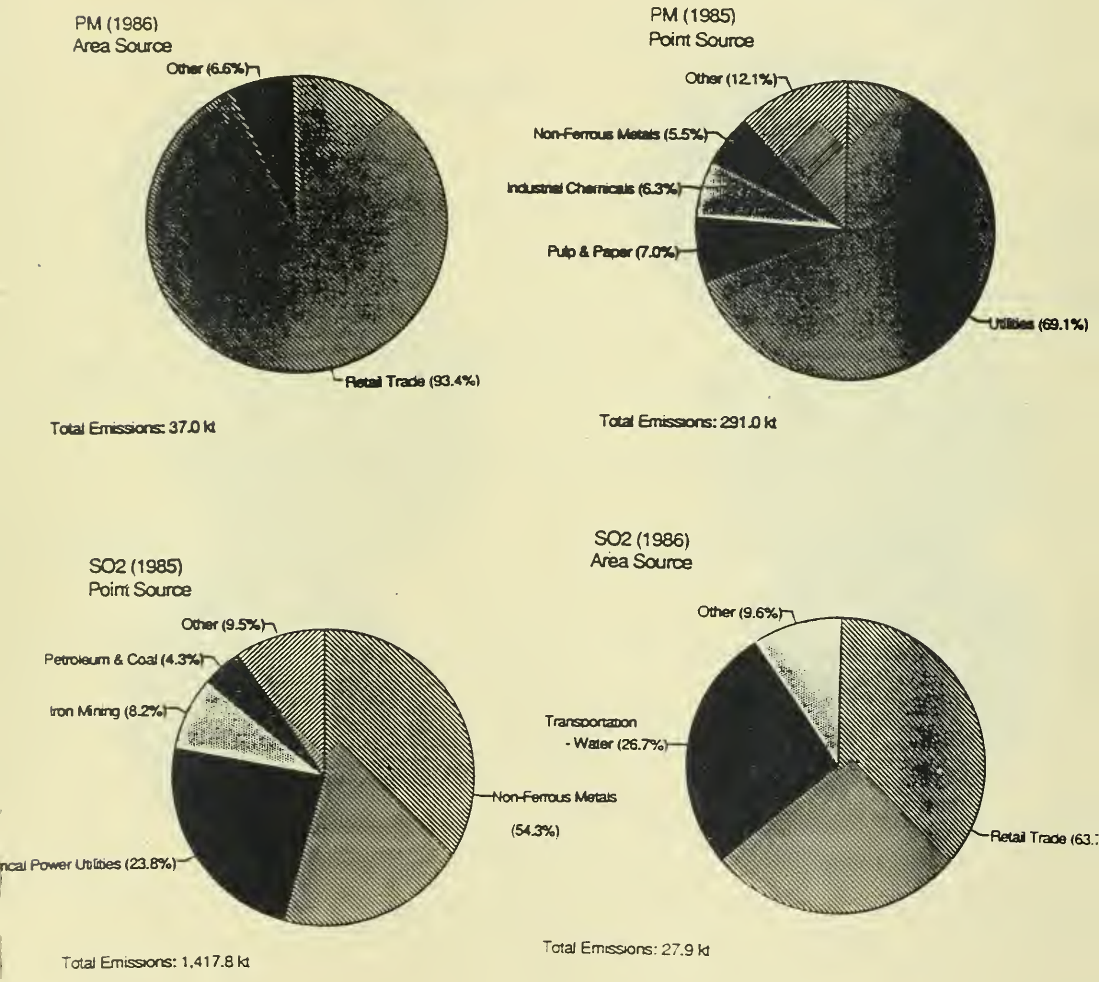
Indicators of energy use include energy consumption and energy supply. Energy consumption is measured in terms of quantity of primary and secondary energy used and is based on Statistics Canada data for 1988 (Catalogue 57-003, Quarterly Report on Energy Supply-Demand in Canada). An energy supply indicator describes energy consumption by energy source, to identify the use of different energy sources with different environmental profiles. Energy supply is discussed in an historical context (see Section 2.2.8) but not as an indicator for comparison across scenarios because the methodology used cannot specify demand by energy type and, therefore, cannot simulate changes in energy supply. Energy supply data were drawn from the same source as energy consumption data.

We emphasize that the energy use indicators are alternative, not supplemental, to the other indicators of waste generation because the latter indicators already encompass some energy-related emissions. For example, the air emission indicators include a specific item for carbon dioxide emissions, which are primarily from energy combustion. Including the CO_2 indicators and the energy use indicators would be double-counting.

4.2.4 Indicator Values

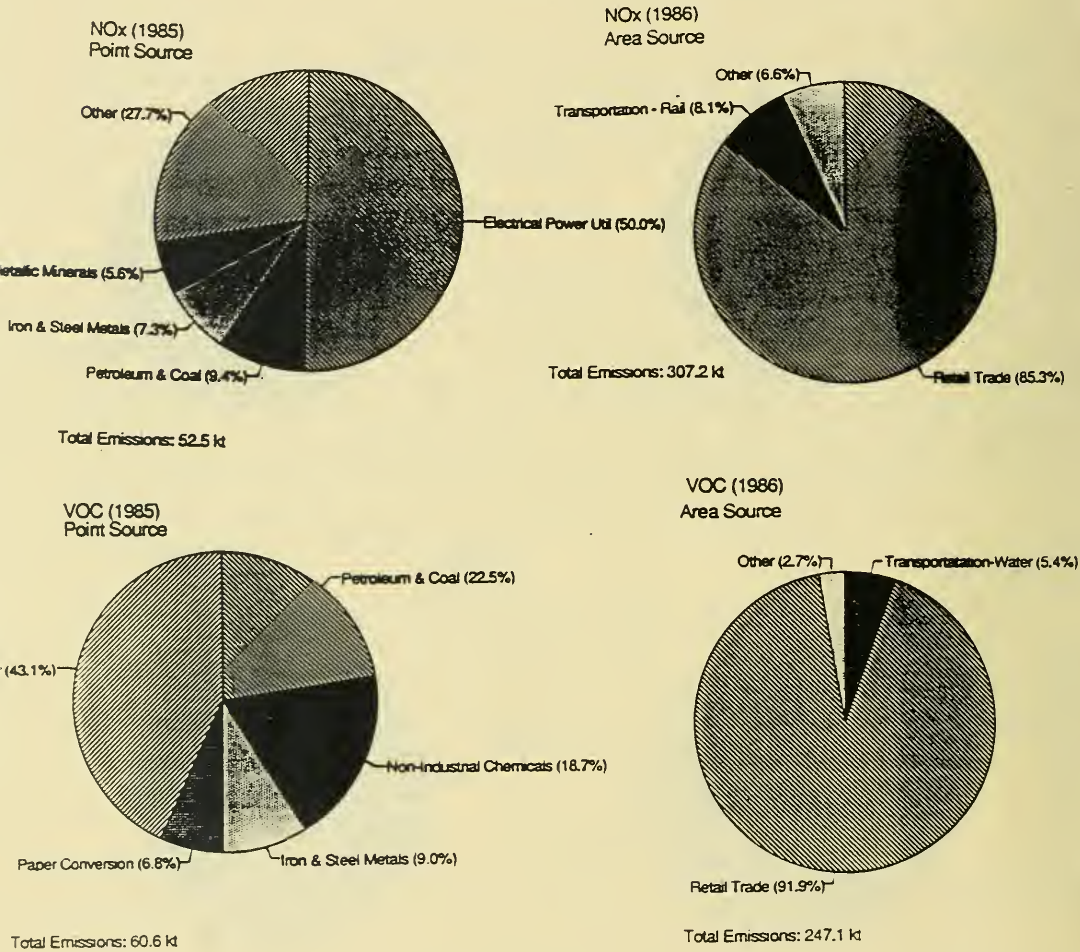
Exhibits 4.3 through 4.6 present base year values for all environmental indicators. Exhibits 4.3 through 4.5 illustrate the major sources of waste generation and total provincial emissions. Total consumption/production is given for resource use and energy consumption in Exhibit 4.6. These base values were used to calculate economy-environment linkages in the form of emission factors/resource use factors. Appendix 1 provides detailed emissions and emission factors for the various waste generation indicators by SIC code for the various waste generation indicators.

Exhibit 4.3: Base Year Values for Environmental Indicators - Air Emissions



Source: VHB Research & Consulting Inc., August, 1991 (point source emissions); Senes Consultant Ltd., January, 1992 (greenhouse gases); Ontario Ministry of Environment, June, 1991 (area-based emissions).

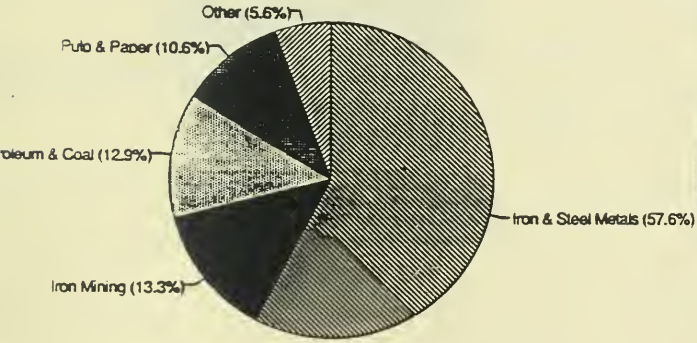
Exhibit 4.3: Base Year Values for Environmental Indicators - Air Emissions (continued)



Source: VHB Research & Consulting Inc., August, 1991 (point source emissions); Senes Consultant Ltd., January, 1992 (greenhouse gases); Ontario Ministry of Environment, June, 1991 (area-based emissions).

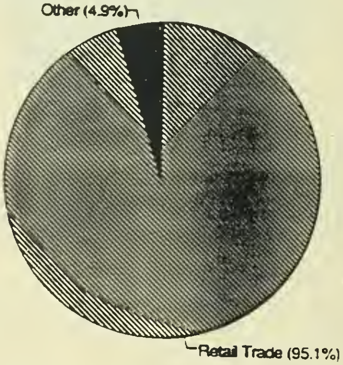
Exhibit 4.3: Base Year Values for Environmental Indicators - Air Emissions (continued)

CO (1985)
Point Source



Total Emissions: 356.4 kt

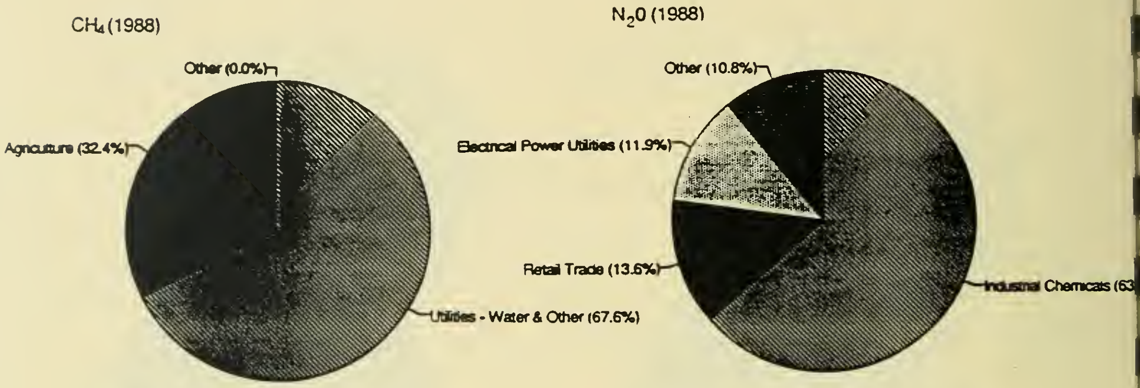
CO (1986)
Area Source



Total Emissions: 1.860.1 kt

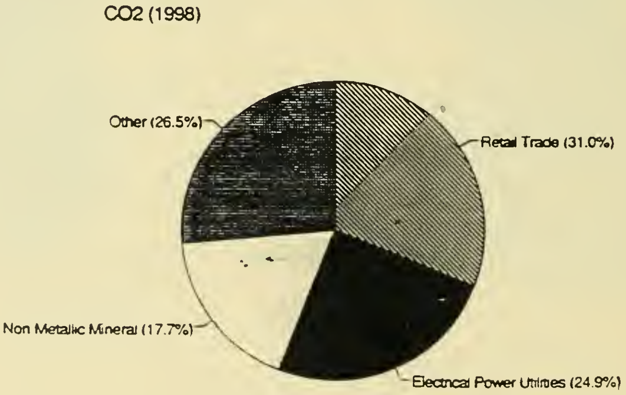
Source: VHB Research & Consulting Inc., August, 1991 (point source emissions); Senes Consultant Ltd., January, 1992 (greenhouse gases); Ontario Ministry of Environment, June, 1991 (area-based emissions).

Exhibit 4.3: Base Year Values for Environmental Indicators - Air Emissions (continued)



Total Emissions: 1,046 kt
(22.0 million tonnes Co2 equivalents)

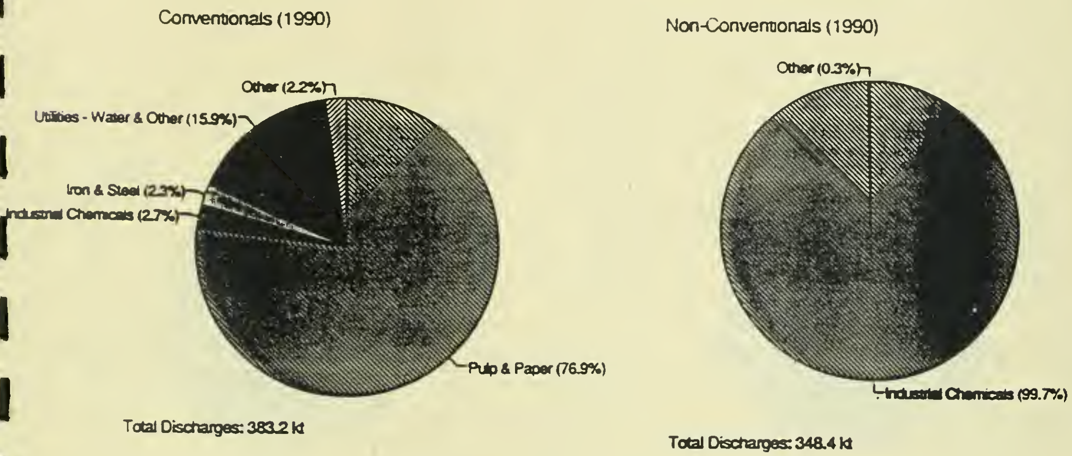
Total Emissions: 33.4 kt
(9.7 million tonnes CO2 equivalents)



Total Emissions: 129.1 million tonnes

Source: VHB Research & Consulting Inc., August, 1991 (point source emissions); Senes Consultant Ltd., January, 1992 (greenhouse gases); Ontario Ministry of Environment, June, 1991 (area-based emissions).

Exhibit 4.4: Base Year Values for Enviromental Indicators - Water Discharges



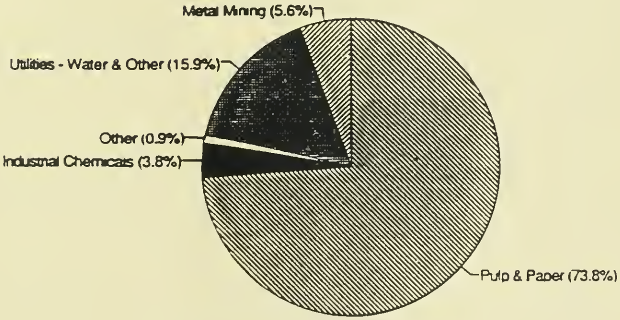
Conventionals (1990)

Total Discharges: 383.2 kt

Non-Conventionals (1990)

Total Discharges: 348.4 kt

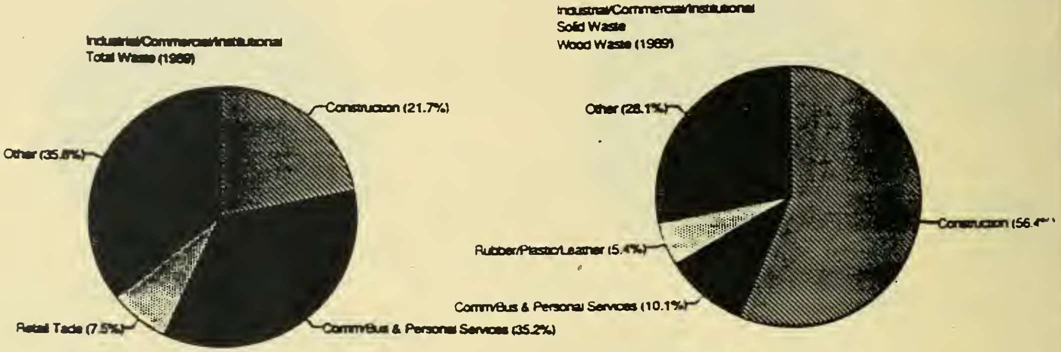
Toxics (1990)



Total Discharges: 5.7 kt

Source: MISA Monitoring Data. 1988 to 1991. Ontario Ministry of Enviroment; Econometric Research Ltd. (1990)

Exhibit 4.5: Base Year Values for Environmental Indicators - Solid Waste



Total Wood Waste Generated: 1130.0 kt

Total Waste Generated: 5361.1 kt

Residential Solid Waste (1989)
Total Waste Generated 4053 kt

Source: CH_2 MHILL Solid Waste Database (1989)

Exhibit 4.6: Base Year Values for Environmental Indicators – Resource Use & Energy Consumption

Indicator		Year	Net Consumption	
Water -	Industrial	1986	328	million cu. m. (net)
	Commercial	1986	348	million cu. m. (net)
	Residential	1986	723	million cu. m. (net)
Minerals -	Metals exculding iron ore*	avg. 1987-89	714 t	
	Iron ore	avg. 1987-89	3170 t	
	Non-metals*	avg. 1987-89	9327 t	
	Structural Materials*	avg. 1987-89	160 kt	
Fertilizer Use		1985	939 kt	
Roundwood Production		avg. 1987-89	27	million cu. m.
Energy Consumption		1988	2,419	Petajoules

Notes: *Excludes minerals for which production data is confidential. Structural excludes clay.

Exhibits 4.3 through 4.5 show that, for most indicators, emissions are concentrated in a few industries. For example, SO_2 point source emissions are sourced from four main industries; CH_4 emissions from two industries; and, as an extreme example, discharges of non-conventionals from one industry -- inorganic chemicals.

The exception to this trend are for NO_X, VOC's, CO_2 and solid waste generation. Point sources for both NO_X and VOC are relatively diffuse -- in both cases four major sources account for 72% and 57% of emissions, respectively as opposed to the 90%+ for other indicators.

The diffuse sources of CO_2 reflect their correspondence with energy use. Solid waste generation is similarly diffused throughout the economy, although services and construction account for about half of total industrial generation. This source pattern is qualitatively different from other environmental indicators in that the focus is on service sectors of the economy. This focus has implications for changes in industrial structure that favour the tertiary sector, as will be seen in the scenario analysis in Section 5.

Emission sources are also surprisingly concentrated across a relatively small number of industries. The concentration of area source emissions in retail trade is clearly illustrated in the pie charts. This concentration reflects the pervasiveness of emissions related to gasoline use, as pump sales are included in this SIC code. Other heavy-emitting industries (that are one of the five major sources for each indicator) are: iron and steel (CO, NO_X, VOC, conventionals); industrial chemicals (PM, N_20, conventionals, non-conventionals, toxins); paper and allied (PM, CO, VOC, conventionals, toxins); electric power utilities (PM, SO_2, N_2O, conventionals, toxins); petroleum and coal (SO_2, CO, NO_X, VOC) and water and other utilities[33] (PM, CH_4, conventionals, toxins).

Although this distribution of emissions is drawn from the best available environmental data, we recognize that collection of emissions data is a relatively new exercise. As discussed earlier in this section, the concentration may substantially reflect the focus of *data collection activities* on these industries/sectors and may in fact overstate the true distribution of emissions. This caveat should be kept in mind throughout the following chapters, but is not likely to affect the conclusions or policy implications drawn from the analysis.

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[33] Includes landfills.

5.0 ENVIRONMENTAL IMPLICATIONS OF RESTRUCTURING

In this chapter, the results of the economic projections are combined with environmental indicators to examine the environmental implications of economic restructuring. Environmental indicators are estimated for each scenario and compared. Quantitative estimates are generated and presented for each of the individual indicators in Exhibit 4.1. Discussion of results for each of the three categories of environmental indicators (waste generation, resource use, energy consumption) is followed by a qualitative discussion of other indicators relating to agriculture, land use, wetlands and wildlife.

Before turning to the results of the analysis, Section 5.1 explains the primary measures used to describe changes in the environmental profile of the Province.

5.1 Measures of Environmental Changes

Differences in the level of emissions or resource use across scenarios can be the result of differences in economic growth or differences in economic structure/industrial composition. Economic growth has powerful impacts on emission/resource use levels. With the exception of Scenario 3, wherein adjustments were made to the emission factors to reflect environmentally induced technological change, this study assumes that production technology is constant. Consequently, it is clear that any increase in productive activity will lead to an increase in waste generation, resource use and energy consumption. For example, in Scenario 2: Domestic Productivity Growth, total GDP is 18% higher than in the base case; all emissions and resource use levels increase by at least 10% and by as much as 25%.

However, as pointed out in the previous section, the assumption of constant technology is constraining so that absolute changes in the level of emissions or resource use that embody differences in GDP growth could be misleading. For example, technological change may improve resource use and reduce consumption rates and waste generation. By ignoring such changes, the environmental impacts of growth may be overstated. To strip out the impact of GDP growth and to isolate changes in emissions and resource use due to *structural changes in the economy*, absolute levels of emissions and resource use are translated into growth-adjusted figures by dividing absolute levels through by provincial GDP. The resulting measure, expressed in terms of tonnes per million dollars GDP (or analogous units) provides a measure of the intensity of environmental and natural resource use by the economy in each of the scenarios. The effect of changes in structure are further isolated by calculating percent differences in growth-adjusted emissions/resource use relative to the base case. All analysis is done for the year 2010, the end point of the simulations. Results are presented in Sections 5.2 through 5.5.

Although the primary focus of this study is on the impact of *structurally-induced* changes in selected environmental indicators, the analysis shows that absolute levels of economic growth are important determinants of the status of environmental resources. *Growth-induced* impacts on environmental indicators are discussed in Section 5.6.

5.2 Implications of Restructuring--Waste Generation

5.2.1 Air Emissions

Exhibits 5.1, 5.2, and 5.3 present the results of the scenario analysis for each of the eight air emission indicators.

Scenario 1: International Growth, and Scenario 2: Domestic Productivity Growth

As illustrated in Exhibit 5.1, none of the first three indicators (SO_2, CO, PM) show any change relative to the Base Case for either Scenario 1 or Scenario 2; that is, emissions per million dollars GDP remain at:

- about 11.2 tonnes for SO_2;
- 13.0 tonnes for CO; and
- 2.3 tonnes for PM.

These results do not imply that there are no changes in emissions on an industry by industry basis. For example, electric power utilities actually increase their contribution to SO_2 emissions, while chemicals decrease their contribution. However, these changes are relatively minor and tend to cancel each other out. Again using SO_2 as an example, the overall GDP share of the large emitting sources remains at 3.9% across all three cases. The specific industry-shares are also relatively stable, as shown below:

Relative GDP Share for Major Industrial SO_2 Sources[34]

Industry/Sector	**Base Case**	**Scenario 1**	**Scenario 2**
	(% of Provincial GDP)		
Metal mining	1.44%	1.44%	1.45%
Electric power utilities	1.74%	1.76%	1.75%
Non-ferrous primary metal	0.55%	0.55%	0.55%
Petroleum and coal	0.17%	0.18%	0.18%
Total Share	**3.90%**	**3.93%**	**3.93%**

Notwithstanding the differences in external and domestic policy assumptions behind scenarios 1 and 2 (relative to the Base Case), then, the overall change in industrial composition is inadequate to generate significant changes in these emissions.

Exhibit 5.2 shows a similar pattern for Scenarios 1 and 2 for NO_X and VOC; that is, changes of less than ±0.2%. As with SO_2, these results reflect changes in individual industry contributions to total emissions that are either very small or tend to cancel out. For example, NO_X growth-adjusted emissions in Scenario 2 encompass increases in the contribution from water and other utilities, electric power utilities, and transportation as well as a number of minor manufacturing sources. Major declines occur in pulp and paper and retail trade as their shares of GDP move from 0.80% to 0.78% and 5.80% to 4.75%, respectively. However, even the largest single change in growth-adjusted emissions--an increase from retail trade--represents less than 1% of total emissions.

Greenhouse gases show somewhat greater differentiation between the Base Case and Scenarios 1 and 2 than other air emissions; however, the changes are still minimal. As illustrated in Exhibit 5.3, the changes range from minus 2-3% for N_2O to plus 4% for CH_4. Increases in CH_4 are driven by emissions from landfills (water and other utilities): although the share of water and other utilities increases only marginally from 0.37% in the base case to 0.40% in both Scenarios 1 and 2, their 75% contribution to total emissions is sufficient to increase growth-adjusted emissions by about 4%. N_2O, which shows a decrease of 2-3% in Scenarios 1 and 2, are driven by industrial chemicals which reduce their share of total GDP from 0.55% in the base case to 0.53% in Scenario 1 and 0.54% in Scenario 2.

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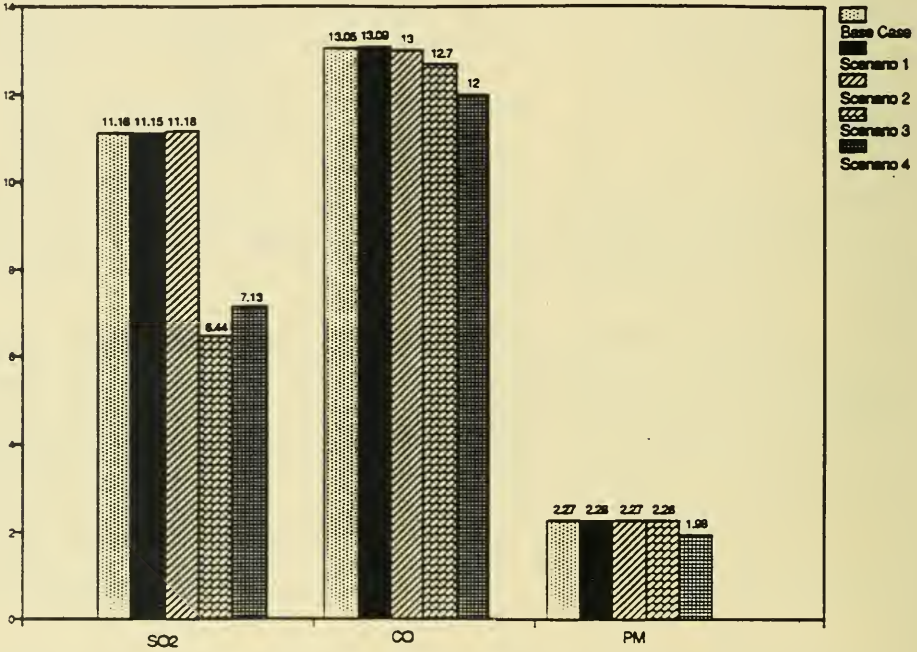
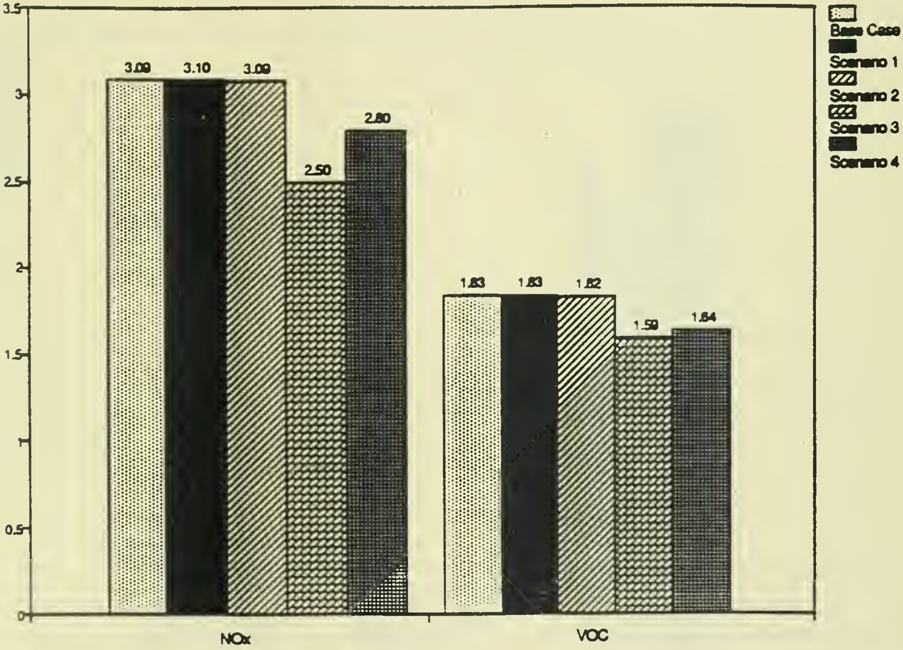
[34] These four major sources account for approximately 93% of total SO_2 emissions in Ontario.

Exhibit 5.1: Air Emissions - SO_2, CO, PM
Growth-Adjusted Emissions (t per M$GDP; Year 2010)



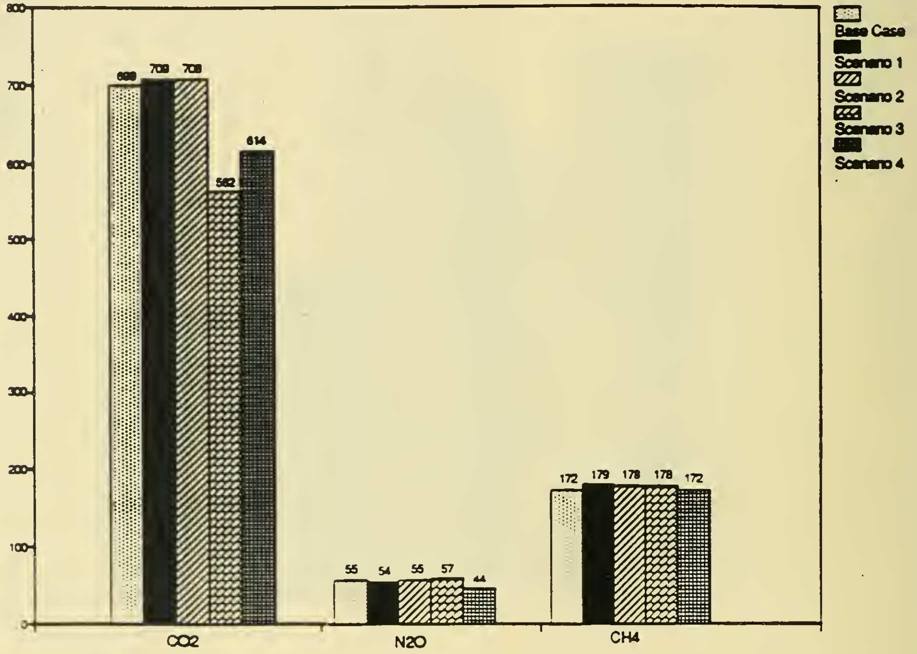
Difference from Base Case (Percent Change)			
	SO_2	CO	PM
Scenario 1	-0.1	+0.3	+0.7
Scenario 2	+0.1	-0.4	+0.3
Scenario 3	-42.3	-2.4	-0.6
Scenario 4	-36.1	-8.5	-12.6

Exhibit 5.2: Air Emissions - NO_x & VOC
Growth-Adjusted Emissions (t per M$GDP; Year 2010)



Difference from Base Case (Percent Change)		
	NO_x	VOC
Scenario 1	0.2	≃ 0.0
Scenario 2	-0.1	-0.2
Scenario 3	-19.6	-13.3
Scenario 4	-9.6	-9.2

Exhibit 5.3: **Air Emissions - Greenhouse Gases Growth-Adjusted Emissions (t, CO2 equivalents per M$GDP; Year 2010)**



Difference from Base Case (Percent Change)			
	CO_2	N_2O	CH_4
Scenario 1	+1.4	-3.1	+4.2
Scenario 2	+1.3	-1.6	+3.6
Scenario 3	-19.6	+3.8	+3.6
Scenario 4	-12.2	-20.5	0.0

Scenarios 3 and 4 present much more significant changes in growth-adjusted air emissions.

Scenario 3: Environmental Initiatives

Scenario 3 results in significant reductions for four major pollutants:

Pollutant	**Growth-Adjusted Emissions (t per M$GDP)**	**Difference from Base Case**
SO_2	6.44	- 42%
NO_X	2.50	- 20%
VOC	1.59	- 13%
CO_2	562	- 20%

These reductions (which also reflect a reduction in the absolute level of emissions) are driven by changes in emission factors, the result of application of abatement technology in response to environmental regulation. For example, the Countdown Acid Rain program is expected to reduce SO_2 by 48% in the electric power sector, 45% in non-ferrous primary metals and by 47% in petroleum and coal. Other regulations embedded in Scenario 3 are:

(i) **NO_X/VOC Controls**
The Federal/CCME NO_X/VOC Management Plan calls for reductions in point sources of these two pollutants to mitigate low level ozone problems. Based on a recent abatement cost study prepared for the Ontario Ministry of the Environment, annual reduction levels associated with the Lowest Achievable Emission Rate (LAER) range from about 55% for NO_X sources to 99% for some VOC sources (VHB Research and Consulting Inc., 1992). Industries/sectors targeted for reductions account for approximately 35% of NO_X emissions and 15% of VOC emissions. The overall impact of the regulations is reductions in the growth-adjusted emission factors of 20% for NO_X and 13% for VOC, relative to the Base Case.

(ii) **National Action Strategy on Global Warming**
Scenario 3 embodies expenditures on environmental initiatives aimed at reducing CO_2 emissions by 20%. Because these expenditures are diffused throughout the economy and could have indirect effects, all CO_2 emission factors (i.e. for all sources) are assumed by the study team to be reduced by 20%. The overall impact on growth-adjusted emissions-

- a reduction of 20%--reflects a dominating effect of regulation-driven reductions relative to changes in industrial composition.

These reductions in emissions are consistent with the environmental investments in Scenario 3 and are based on the 1990 federal "Green Plan". Informetrica, in a 1991 paper, had created estimates of capital spending that would be associated with the plan and these numbers were used as a starting point. These investment estimates were adjusted to reflect research on various aspects of environmental plans done since the publication of the Green Plan. The Ministry of the Environment provided estimates from Countdown Acid Rain (capital spending by Inco and Falconbridge and Ontario Hydro). Estimates were also included for the Ontario Hydro Conservation Plan and the Toronto Transit Commission's Let's Move initiative.

The force of regulation-driven emission reductions is further illustrated by the static levels of growth-adjusted emissions for non-regulated pollutants (PM, CO, N_2O, CH_4).

Although the effect of regulation dominates growth-adjusted emissions relative to the Base Case, changes in industrial structure that are the indirect effect of environmental regulations also affect emissions. In most cases, these indirect structural effects augment the regulation-driven reductions. For example, the growth-adjusted emissions from electric power utilities is 54% lower in Scenario 3 relative to the Base Case. This reduction exceeds the regulation-driven reduction of 48% because the industry's share of GDP falls from 1.74% in the Base Case to 1.61% in Scenario 3. Similarly, regulation-driven reductions in petroleum and coal are augmented by a deterioration in its share of GDP from 0.17% in the Base Case to 0.09% in Case Scenario 3.

In summary, changes in growth-adjusted emissions in Scenario 3 are dominated by the direct effect of changes in emission factors brought about by environmental regulations and augmented slightly by changes in industrial composition that are the indirect result of regulations. The improvement in emission profiles for regulated pollutants is dramatic, while non-regulated pollutants change marginally, if at all.

Scenario 4: Industrial Shift Case: The fourth Scenario explores a paradigm shift in the economic structure of the Province. Changes in industrial composition embedded in Scenario 4 have a significant impact on their emissions indicators. As illustrated in Exhibit 5.1 through 5.3, the paradigm shift scenario results in a dramatic decrease in emissions of SO_2 and N_2O (-36% and -20%, respectively) and a notable decrease in growth-adjusted emissions for CO, PM, NO_X and

VOC. The underlying causes of these reductions in terms of change in industrial composition, are explained below.

(i) **Sulphur Dioxide (SO_2)**

Four major sources account for 93% of total SO_2 emissions. The shares of these industries in total GDP decline dramatically in Scenario 4 relative to the Base Case:

	Relative Share of GDP (% of Provincial GDP)	
Industry	**Base Case**	**Scenario 4**
Metal Mining	1.44%	0.80%
Electric power utilities	1.74%	1.70%
Non-ferrous primary metals	0.55%	0.30%
Petroleum and Coal	0.17%	0.10%
Total share	**3.90%**	**2.90%**

(ii) **Nitrous Oxides (N_2O)**

N_2O emissions are driven by production in the industrial chemicals industry. In Scenario 4, the share of this industry in total GDP declines from 0.55% to 0.40%. The impact of this shift is augmented by a decline in pulp and paper's share from 0.80% to 0.50%.

(iii) **Carbon Monoxide (CO)**

Transportation services, which account for 7% of total base case emissions, experience a decline in GDP share from 3.81% to 3.28%. The major source of emissions -- retail trade (gasoline sales) -- maintains its share, resulting in a more modest overall decline in growth-adjusted emissions of 8%.

(iv) **Nitrogen Oxides (NO_X)**

In addition to the transportation service's impact on area-based NO_X emissions, point sources of emissions are reduced through the following shifts in GDP share:

	Relative Share of GDP (% of Provincial GDP)	
Industry	**Base Case**	**Scenario 4**
Electric power utilities	1.74%	1.70%
Pulp and Paper	0.80%	0.50%
Primary metals	1.90%	1.09%
Petroleum and Coal	0.17%	0.10%
Total Share	**4.61%**	**3.39%**

These changes are sufficient to offset increased emissions from commercial sources, commensurate with an increase in services from 19.1% of GDP to 21.4% of GDP. (Although this is a relatively significant increase in GDP share, the emission factor for service-related NO_X emissions is relatively low.)

(v) **Particulate Matter (PM)**

Four major sources, accounting for 85% of total PM emissions, experience declines in GDP shares as follows:

	Relative Share of GDP (% of Provincial GDP)	
Industry	**Base Case**	**Scenario 4**
Total Utilities	2.41%	2.38%
Pulp and Paper	0.80%	0.50%
Primary Metal	1.90%	1.09%
Industrial Chemicals	0.55%	0.40%
Total Share	**5.66%**	**4.37%**

(vi) **Volatile Organic Compounds (VOC)**

VOCs are emitted from a large number of area and point sources. In Scenario 4, however, five major sources, accounting for 25% of total emissions (transportation services, paper and allied industries, primary metals, petroleum and coal, chemicals) all experience significant reductions in share of GDP. Analogous to growth-adjusted emissions for CO, NO_X and CO_2, the overall reduction in growth-adjusted emissions are tempered by a static share of GDP of one large source: retail trade (gasoline sales).

(vii) **Carbon Dioxide (CO_2)**

Reductions in the share of transportation services, electric power utilities, pulp and paper and non-metallic minerals more than offset increases in growth-adjusted emissions from services, which experience an increase in GDP share from 19.1% to 21.4%.

The results of the Scenario 4 analysis for air emissions indicate that dramatic changes in industrial structure away from environmentally damaging industries can result in a significant improvement in the environmental profile (with respect to air emissions) in the Province. All pollutants show a decline in growth-adjusted emissions. In some cases, these reductions are more substantial than in Scenario 3; whereas for other pollutants, the reductions are more modest. For example, SO_2 growth-emission reductions in Scenario 4 are higher than in Scenario 3, although both are significantly (36% to 42%) lower than the Base Case. By contrast, N_2O emissions under Case 3 represent a 4% increase relative to the Base Case but a 20% reduction in Scenario 4. As may be expected, Scenario 4 leads to a more general pattern of emissions reductions than Scenario 3 where reductions are targeted through environmental regulation.

5.2.2 Industrial Water Discharges

Exhibit 5.4 presents the levels and changes in growth-adjusted discharges for the Base Case and all four scenarios. As indicated, water discharges have been broken out by conventionals, non-conventionals, and toxics. All three categories of discharges show the same basic pattern which was reflected in the air emissions results; that is, there is very little change in the indicators in Scenarios 1 and 2 relative to the Base Case, with much more significant changes in the Environmental Initiatives and Industrial Shift cases (Scenarios 3 and 4).

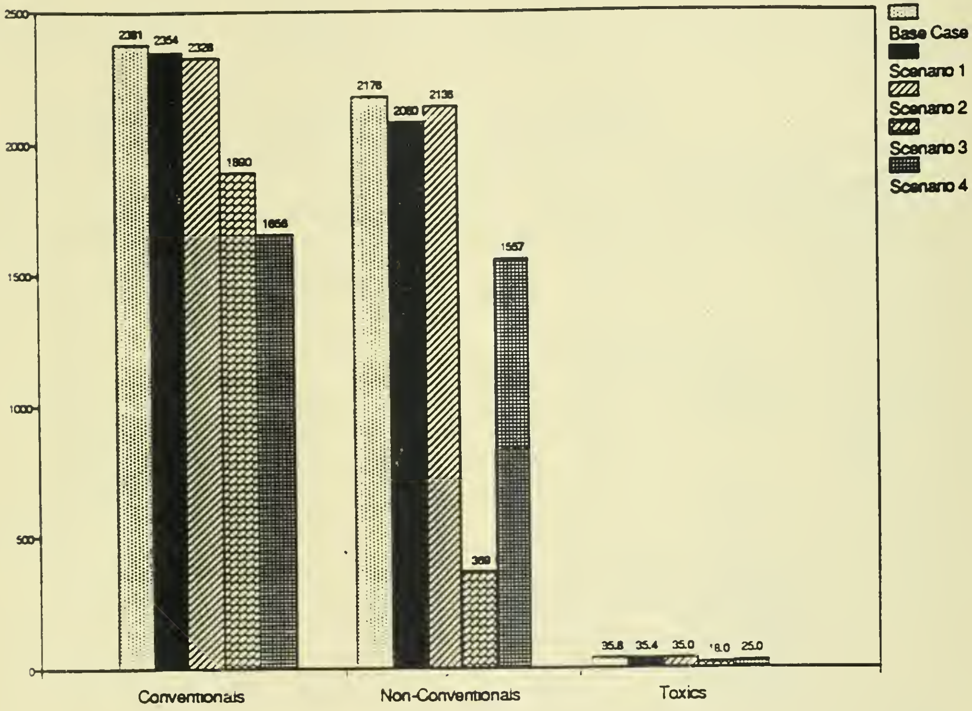
Changes in growth-adjusted discharges for either Scenario 1 or Scenario 2 do not exceed ± 4.4% relative to the Base Case. The minor shifts for conventionals and toxics have their root in changes in pulp and paper. For both indicators, pulp and paper accounts for 70-73% of total identified discharges. While other source industries maintain or even increase their share (e.g., iron and steel in Scenario 2), pulp and paper's share of GDP declines from 0.80% in the base case to 0.77% and 0.76% in Scenarios 1 and 2, respectively.

The somewhat larger decline (4.4%) in discharges of non-conventionals is the result of a decrease in the GDP share of industrial chemicals. Specifically, industrial chemicals experience a drop in GDP share from 0.55% in the Base Case to 0.53% and 0.54% in Scenarios 1 and 2, respectively. Although these are seemingly small share changes (about 4%), the large emission factor and the fact that industrial chemicals account for 99% of total non-conventional discharge loadings, results in an overall decline in growth-adjusted discharges of non-conventionals. Nonetheless, taken in a broad policy context, none of the changes calculated for Scenarios 1 or 2 are significant.

The MISA initiative underlies the results for Scenario 3. Detailed analysis of five of the ten regulated sectors was provided by the Ministry and have been included in the results for this scenario. Actual levels of abatement for the MISA program have yet to be determined, so projected reductions relate to the estimated maximum level of abatement that is technically feasible. Exhibit 5.5 provides the projected annual reductions assumed in Scenario 3 for specific industries. As indicated, projected reductions are generally very high: greater than 90% for all types of discharges in the iron and steel industry, between 70% and 90% reductions in pulp and paper (toxics), industrial chemicals (conventionals, non-conventionals), petroleum and coal (toxics), and between 25% and 50% reductions in water and other utilities (conventionals), petroleum and coal (conventionals), and industrial chemicals (toxics).

Weighted by shares of Base Case discharges, the average reductions over all target sources are projected as 21% for conventionals, 84% for non-conventionals, and 57% for toxics. The lower reduction for conventionals can be explained by pulp and paper emissions which are expected to decline by only 11%, although they account for over 70% total discharges. Notwithstanding the significant reduction (78%) in the largest source of toxic discharges (pulp and paper), the overall projected reduction in toxics is tempered by the role of sewage treatment plants; the MISA program is expected to yield some reductions in toxic discharges from sewage treatment plants, but projected reductions have not been estimated and, therefore, are not included in the analysis.

Exhibit 5.4: Industrial Water Discharges
Growth-Adjusted Discharges (kg per M$GDP)



Difference from Base Case (Percent Change)			
	Conventionals	**Non-Conventionals**	**Toxics**
Scenario 1	-1.1	-4.4	-1.1
Scenario 2	-2.2	-1.8	-2.0
Scenario 3	-20.6	-83.0	-48.9
Scenario 4	-30.4	-28.5	-30.6

Exhibit 5.5: Reductions in Water Discharges Projected Under Maximum Reduction Technically Feasible Option Identified by the MISA Program

Industry	Conventionals		Non-Conventionals		Toxics	
	% Base Case Discharges	Annual Reductions	% Base Case Discharges	Annual Reductions	% Base Case Discharges	Annual Reductions
Sewage Treatment Plants	19	48%	--	--	19	?[f]
Pulp & Paper	73	11%	--	--	70	78%
Iron & Steel	2	98%	< 1	99%	1	93%
Petroleum & Coal[a]	< 1	41%	--	--	< 1	82%
Industrial Chemicals	3	70%	99	84%	4	25%
Total	**97[b]**	**21%[c]**	**100**	**84%[c]**	**94[d]**	**57%[c]**

Notes:
[a] Mainly petroleum refining
[b] Metal mining accounts for about 3% of discharges but has not been allocated reduction targets.
[c] Weighted average
[d] Metal mining accounts for about 6% of toxic discharges
[e] Year 2010
[f] Unknown at present

Source: ARA Consulting Group Inc., Ontario Ministry of Environment

The reduction in growth-adjusted discharges for conventionals, non-conventionals and toxics, as presented in Exhibit 5.4, closely follow the totals given in Exhibit 5.5. The difference between the two sets of estimates are that the values given in Exhibit 5.5 are based on Base Case industrial composition; the values given in Exhibit 5.4 reflect the industrial composition of Scenario 2, from which Scenario 3 was developed.[35] The fact that the two sets of values correspond so closely further illustrates the dominance of regulatory impacts on changing emission levels, rather than the influence of changes in industrial composition. The exception to the pattern lies with toxics where Scenario 3 simulations estimate a 49% decrease in discharges compared to an average based on Base Case discharges of 57%. The more modest decline in the Scenario 3 simulation is attributable to a significant increase in the share of water and other utilities relative to the Base Case: from 0.37% to 0.53%. As indicated in Exhibit 5.5, water and other utilities are the major source of toxic discharges.

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[35] As explained in Section 3, Scenario 3 embodies all assumptions regarding internal and external economic forces that drive Scenario 2. The only difference between the two scenarios is the impact of environmental expenditures to meet provincial or national environmental regulations.

As discussed in Section 2, Scenario 4 identifies environmentally damaging industries and forces structural change away from these to more environmentally benign economic activities. All source industries for water discharges fall into this group of environmentally damaging industries, with the exception of water and other utilities. The GDP shares of water discharge industries are reduced in Scenario 4 as follows:

	Relative Share of GDP (% of Provincial GDP)	
Industry	**Base Case**	**Scenario 4**
Metal mining	1.44%	0.80%
Water and other utilities	0.37%	0.37%
Pulp and paper	0.80%	0.50%
Iron and steel	1.35%	0.80%
Petroleum and coal	0.17%	0.10%
Industrial chemicals	0.55%	0.40%
Total Share	**4.68%**	**2.97%**

These shifts in share of GDP cause an overall reduction in growth-adjusted discharges for conventionals of 30%, of 28% for non-conventionals, and 31% for toxics (see Exhibit 5.4).

There is no distinct pattern in these results relative to Scenario 3. In one case -- non-conventionals -- it is very clear that even significant shifts away from industrial chemicals will not result in the level of emission reductions expected from the MISA program. On the other hand, conventionals discharges may be more structurally sensitive, with a 30% decline in Scenario 4 compared to a 21% decline under the MISA program. It should be recalled, however, that the shifts in industrial composition embodied in Scenario 4 are dramatic, falling outside actual experience over the past 20 years. The degree to which such significant shifts in industrial composition can act as a form of environmental policy is discussed in depth in Chapter 6.

5.2.3 Solid Waste[36]

The residential solid waste indicator captures generation of solid waste by households. It differs from other indicators in that it is predicated on a change in population rather than a change in GDP. As indicated in Exhibit 5.6, the growth-adjusted generation of residential solid waste declines in all scenarios. This modest drop of 8% in Scenarios 2 and 3 reflects increasing per capita income in all scenarios; as population rises more slowly than GDP, residential waste as a function of GDP will, by definition, decline.[37]

Exhibit 5.6 also presents results for industrial waste generation. Industrial waste has been broken down into two indicators: wood waste and other waste. Wood waste was separated out because it serves as a direct indicator of a stress on a renewable resource. Other wastes also implies stress on resources (e.g., petroleum) but linkages are not as obvious. For either indicator, there is very little change in growth-adjusted waste generation across all scenarios. The results for Scenarios 1 and 2 underscore the conclusions from the analysis of air emissions and water discharges; that is, that foreseeable changes in industrial composition do not result in shifts in environmental profile.

In the case of industrial waste, Scenario 3 also supports this conclusion. Like PM, CO, CH_4, and N_2O, Scenario 3 does not include environmental regulations that affect emission factors. Several waste reduction initiatives have been proposed, discussed extensively and implementation has begun (e.g., the National Packaging Protocol, the Ontario Waste Reduction Action Plan). These initiatives are expected to significantly reduce waste generation (by up to 50%). However, lack of data precluded cost estimates for these initiatives and, to maintain consistency in the analysis, emission (waste generation) factors for individual industries were also left unchanged. Scenario 3 for waste generation, then, provides another look at the impact of foreseeable industrial composition on the environmental profile, but may understate the effect of environmental initiatives that are, in a policy sense, part of Scenario 3, but have not been quantified and, hence, embodied in the model simulations.

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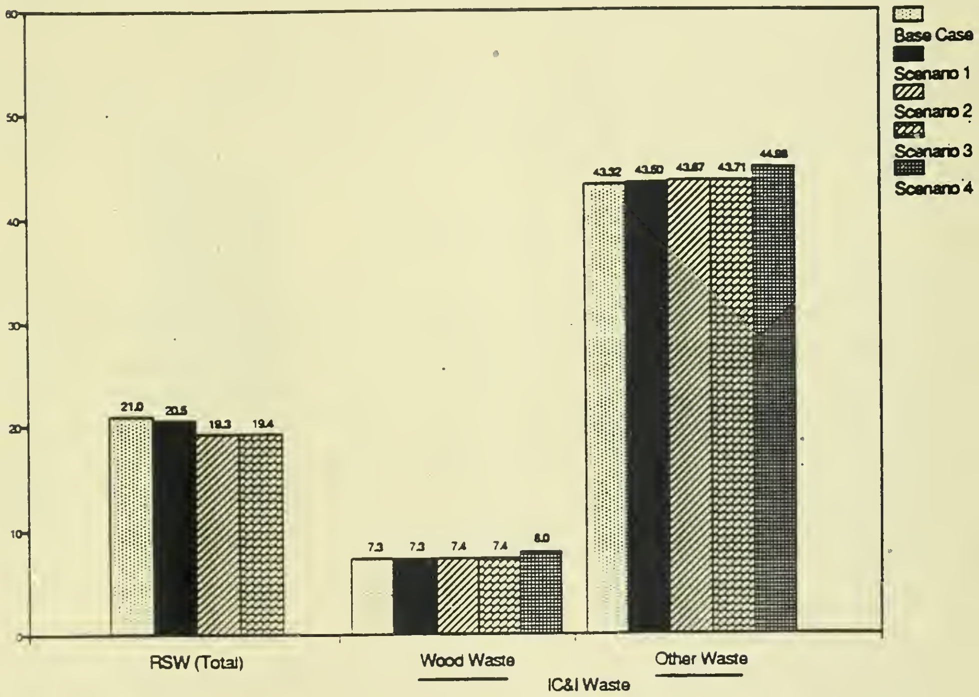
[36] Hazardous wastes are not included in this category.

[37] Population estimates were not made for Scenario 4; therefore, municipal solid waste could not be estimated. It is assumed, because GDP remains the same, that population and therefore municipal solid waste are approximately in the Base Case and Scenario 4.

Exhibit 5.6: Solid Waste Growth-Adjusted Generation (tonnes per M$GDP; Year 2010)



Difference from Base Case (Percent Change)			
	Residential Solid Waste	IC&I Wood Waste	Other IC&I Waste
Scenario 1	-2.1	-0.8	-0.0
Scenario 2	-7.9	+0.3	+0.3
Scenario 3	-7.6	+1.0	+0.4
Scenario 4	na	-8.6	-3.3

Unlike results for air emissions and water discharges, the results for Scenario 4 suggest very little change in waste generation resulting from a fairly significant shift in industrial composition. This result is an artifice of the criteria used to identify environmentally damaging industries. Specifically, environmentally damaging industries were dominated by air and water emitters and heavy resource consuming industries. By contrast, the major solid waste generators are services (32% of Base Case waste generation), construction (21%), and trade (10%). In Scenario 4, both services and construction increase rather than decrease their share of GDP.[38] As industrial composition is modified away from direct emitters, then, greater emphasis is placed on service sectors that are not wholly environmentally benign. This is reflected in the 3% increase in growth-adjusted industrial waste generation over the Base Case.

5.3 Implications of Restructuring--Resource Use

The second category of environmental indicators is resource use. As discussed in Section 4, four separate indicators are considered: water use, mineral production, fertilizer use, and roundwood production. With the exception of water use, changes in growth-adjusted consumption depend solely on the economic performance of a single industry. In the case of fertilizer use, that industry is agriculture; in the case of roundwood production, that industry is logging and forestry industries. Changes in growth-adjusted consumption relative to the Base Case, therefore, are due to changes in the GDP share of that industry. The results of changes in industrial composition on the four indicators of resource use are presented in Exhibit 5.7 through 5.9 and are summarized below.

5.3.1 Water Use

Water use is broken up by residential, commercial and industrial net consumption (i.e. intake minus discharges). Results are presented in Exhibit 5.7.

Residential Consumption

Growth-adjusted residential consumption of water declines by 2% in Scenario 1, and about 8% in both Scenarios 2 and 3. As they did in the case of residential solid waste generation, these results reflect increasing real per capita incomes. Because residential water use is based on

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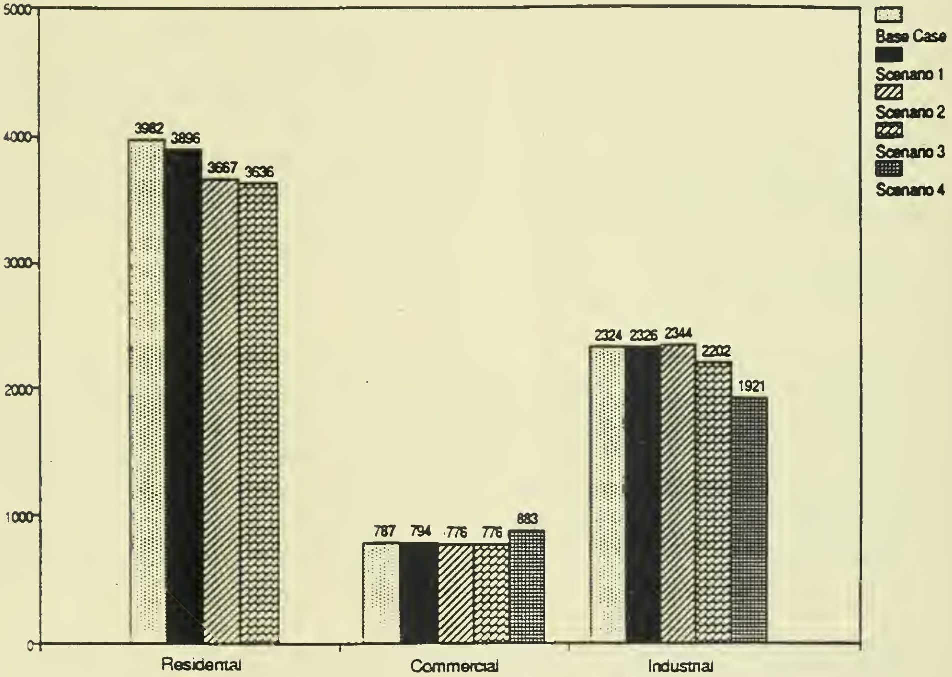
[38] Specifically, services share of GDP increases from 19.1% in the Base Case to 21.4% in Case 4; construction increases from 7% to 8.6%.

Exhibit 5.7: Water Use Growth-Adjusted Consumption (cu.m. per M$GDP; Year 2010)



Difference from Base Case (Percent Change)			
	Residential	Commercial	Industrial
Scenario 1	-2.1	+0.8	+0.1
Scenario 2	-7.9	-1.4	+0.8
Scenario 3	-8.3	-1.4	-5.3
Scenario 4	na	-12.1	-17.3

population, and population rises less rapidly than GDP in each of the scenarios, residential water consumption per million dollars GDP falls across all scenarios.

Commercial Water Use

Commercial water consumption changes only marginally over the first three scenarios. The slight increase in Scenario 1 is due to a small rise in the share of services in total GDP. Conversely, the slight decrease (of approximately 1% relative to the Base Case) in Scenarios 2 and 3 are attributable to a decline in the share of services from 19.1% in the Base Case to 18.8%. Scenario 4 represents a conscious attempt to increase the share of services relative to highly polluting industries. The implication of such an increase is a rise in growth-adjusted water use of approximately 12% to 880 cubic meters per million dollars GDP.

Industrial Water Use

Changes in growth-adjusted water consumption in the industrial sector are inconsequential in Scenarios 1 and 2; that is, foreseeable changes in industrial composition do not lead to a change in water use. Stronger changes are induced in the environmental initiatives scenario, notwithstanding the fact that the scenario embodies no direct regulation on water use. The 5% decline relative to the Base Case is attributable to reduced shares of the electric power utility, pulp and paper, and petroleum and coal industries (that experience heavy expenditures to meet regulations) that offset increases in the transportation and chemicals. Together, these three industries account for almost 50% of net provincial industrial water use.

Scenario 4 reflects an extension of these industrial shifts. Specifically, electric power utilities, pulp and paper, and petroleum and coal experience a decline in GDP share from 2.7% in the Base Case to 2.3% in Scenario 4. In addition, other significant water users lose GDP share:

	Relative Share of GDP (% of Provincial GDP)	
Industry	**Base Case**	**Scenario 4**
Primary metals	1.90%	1.09%
Transportation equipment	5.56%	3.91%
Industrial chemicals	0.55%	0.40%
Total Share	**8.01%**	**5.40%**

The reduction in industrial water use embodied in Scenario 4 is more than sufficient to offset the increase in commercial water use. Specifically, commercial plus industrial water use decreases from about 3,110 cubic meters per million dollars GDP in the Base Case to 2,800 in Scenario 4, a decline of almost 10%. A shift in industrial composition away from heavy air and water emitters, then, will also result in a reduction in the intensity of net water consumption in the Province.

5.3.2 Mineral Production

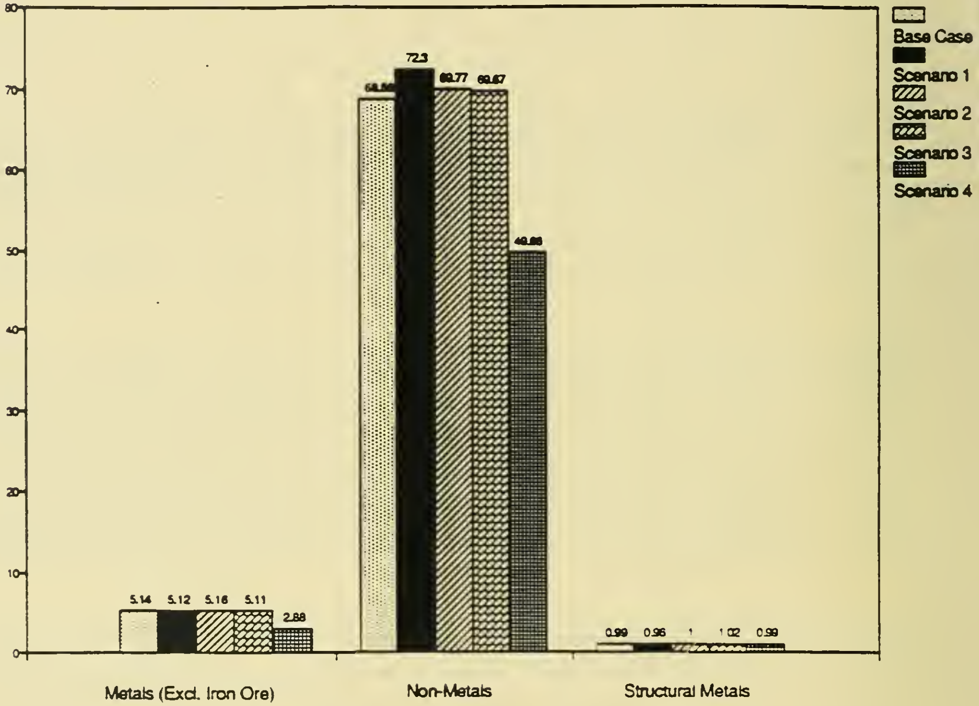
The impact of industrial composition shifts on growth-adjusted mineral production is considered separately for metals (excluding iron ore), non-metals, and structural materials (see Exhibit 5.8). Results for metals (excluding iron ore) reflects a now-familiar pattern: insignificant changes relative to the Base Case in Scenarios 1, 2, and 3, consistent with the little if any shifts in the GDP share of metal mining (excluding iron ore). Analogous results are found for iron ore mining.

The results for Scenario 3 do, however, warrant a word of caution. As indicated in earlier chapters of this report, neither the economic model nor the environmental indicators embody technological change or, perhaps more relevant to the results in Exhibit 5.8, the introduction of clean technologies that reduce requirements for raw materials. A greater awareness of raw material use, waste management, and good environmental corporate citizenship, spurred by provincial environmental initiatives, could result in greater reductions in mineral consumption than suggested by the simple shift in GDP share.

In Scenario 4, metal mining (iron ore and other) experiences a sharp reduction in share of GDP from 1.44% in the Base Case to 0.80%. Indeed, iron ore mining as an activity is essentially eliminated. The implication for growth-adjusted metals consumption is, predictably, significant; a decline of more than 40% from 5.1 kilograms per million dollar GDP to less than 2.9 kilograms per million dollar GDP.

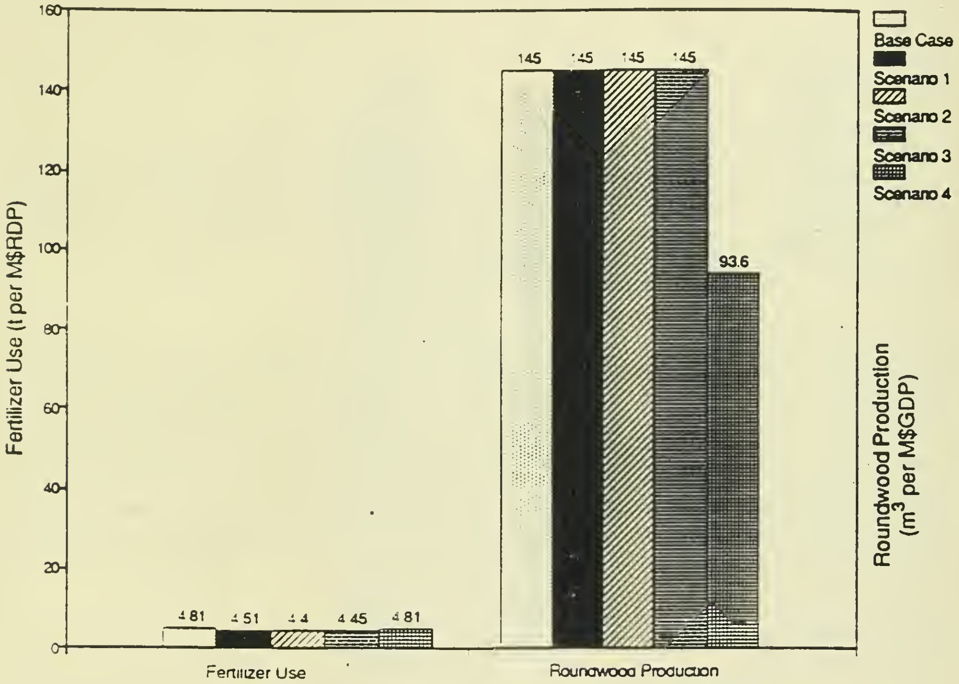
The pattern of results is repeated for non-metals and structural materials (see Exhibit 5.8); relatively little change in growth-adjusted production in Scenarios 1, 2, and 3 reflecting minor fluctuations in GDP share of these two mining sectors. The more significant decline in growth-adjusted production for non-metals in Scenario 4 is attributable to a decline in GDP share from 0.06% in the Base Case to 0.04% in Scenario 4. The share of quarry and sand pit mining in total GDP does not change between the Base Case and Scenario 4, resulting in a constant growth-adjusted production level of about one tonne per million dollars GDP.

Exhibit 5.8: Mineral Production
Growth-Adjusted Production (kg per M$GDP; Year 2010)



Difference from Base Case (Percent Change)			
	Metals (excl. iron ore)	Non-Metals	Structural Metals
Scenario 1	-0.4	-2.8	-2.6
Scenario 2	+0.5	+1.8	+1.5
Scenario 3	-0.5	+1.6	+3.6
Scenario 4	-44.0	-27.6	0.0

Exhibit 5.9: Industrial Roundwood Production & Fertilizer Use Growth-Adjusted Use (Year 2010)



Difference from Base Case (Percent Change)		
	Fertilizer	Roundwood Production
Scenario 1	-6.2	0.0
Scenario 2	-8.6	0.0
Scenario 3	-7.6	0.0
Scenario 4	0.0	-35.5

In summary, mineral production appears to be only marginally affected by changes in industrial composition driven by external factors or domestic policies, including environmental initiatives. The intensity of the province's consumption of its mineral resources is not, however, a constant; a conscious and dramatic policy shift away from "environmentally damaging" industries (including mining) could have significant implications, as illustrated by the results for Scenario 4.

5.3.3 Fertilizer Use

Changes in growth-adjusted fertilizer use exactly mirror the decline in agriculture's share of GDP: from 1.25% in the Base Case to 1.17% in Scenario 1, 1.14% in Scenario 2, and 1.16% in Scenario 3. (Agriculture's share of GDP is assumed to remain constant at 1.25% in Scenario 4.) In Scenarios 1 through 3, then, growth-adjusted fertilizer use is estimated to decline from 6% to 8%, depending on the specific scenario.

However, this decline may actually underestimate potential changes because of the assumption of constant technology (and, implicitly, constant practices). For example, the amount of commercial fertilizer applied on Ontario farm lands declined 4% between 1980 and 1985, notwithstanding constant real agriculture GDP. Increasing concern for water quality impacts and soil nutrient levels may lie behind this trend; continued awareness education and concern over the environmental implications of modern agricultural practices may extend or even accelerate this trend in the future. In the environmental initiatives scenario, in particular, the decline in growth-adjusted fertilizer use may be underestimated.

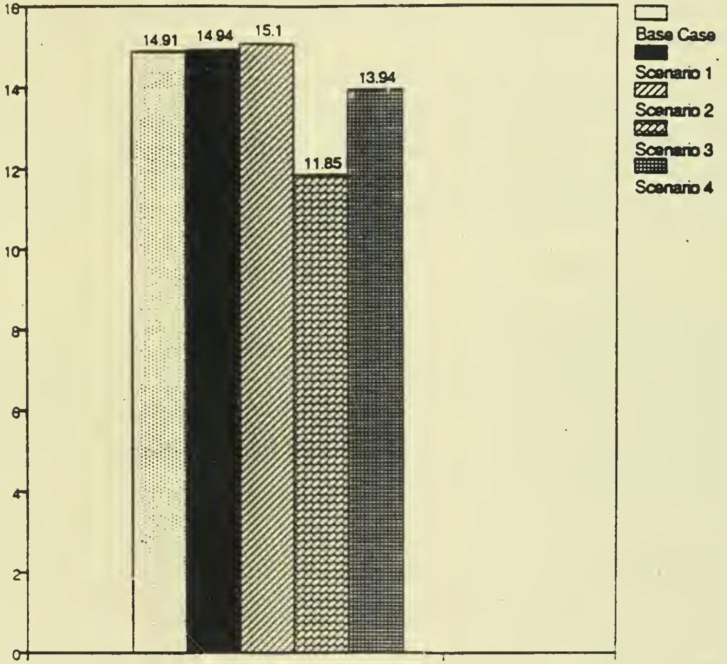
5.3.4 Roundwood Production

The various internal and external forces (including the environmental initiatives package), embedded in Scenarios 1 through 3 do not affect the share of logging and forestry in total GDP: it remains constant at 0.31%. Consequently, the Province's intensity of use of forest resources (in the form of roundwood production) remains constant at about 147 cubic meters per million dollar GDP. The decline in the growth-adjusted figure in Scenario 4 is commensurate with the decline in this industry's share of GDP to 0.20%.

5.4 Implications of Restructuring--Energy Consumption

The results of the scenario analysis for energy consumption indicators are presented in Exhibit 5.10. The shifts in economic structure embedded in Scenario 1 are, as indicated, insufficient

Exhibit 5.10: Energy Consumption - Commercial and Industrial Growth-Adjusted Consumption (TJ per M$GDP; Year 2010)



	Difference from Base Case (Percent Change)
Scenario 1	+0.2
Scenario 2	+1.3
Scenario 3	-20.5
Scenario 4	-6.5

to generate a change in the energy intensity of the provincial economy. In Scenario 2, with slightly greater emphasis on transportation and manufacturing, energy intensity increases marginally. The results for Scenario 3 are driven by an assumption that the environmental initiatives associated with reductions of carbon dioxide and mitigation of the threat of global warming will reduce energy consumption by 20% (i.e. the energy use factors for all sectors were reduced by 20% in this simulation). Analogous to the results for other indicators, the effects of the economic structural change in Scenario 3 are inconsequential relative to the effects of environmental regulation.

In Scenario 4, all major energy use sectors and industries experience a decline in their share of GDP, resulting in an overall decline in the energy-intensity of the provincial economy. However, increases (or constant) shares for services and trade dampen the overall reduction in energy intensity to about 6% below Base Case levels.

5.5 Environmental Implications of Economic Growth

As noted above, differences in the level of emissions or resource use across scenarios can be the result of differences in economic growth or differences in economic structure. The main focus of this study is the impacts of structural change; the results of the analysis suggest that only significant shifts in industrial composition are likely to generate noteworthy changes in the environmental profile of the Province.

However, the model situations did indicate that economic *growth* can have a significant impact on environmental indicators. In this section, we briefly review the environmental implications of economic growth for two indicators: NO_X emissions and energy consumption.

Growth in GDP

All scenarios have embedded in them economic expansion, although the rates of growth differ, as follows:

Base Case: GDP increases 74% in real terms between 1992 and 2010 from $160 billion to $278 billion;

Scenario 1: GDP growth is higher than in the Base Case, increasing 97% to $316 billion -- by the year 2010, GDP is 13.6% higher than under the Base Case;

Scenario 2: GDP about doubles to $328 billion, or 17.7% higher than Base Case GDP in the year 2010;

Scenario 3: GDP rises slightly less than in Scenario 2 due to the dampening impact of regulation-driven environmental expenditures to $327 billion, or 17.3% higher than the Base Case in the year 2010; and

Scenario 4: GDP follows the same path as the Base Case by design -- Scenario 4 was intended to isolate the impact of significant changes in industrial structure with the same total GDP figure and is, therefore, not discussed in this section.

Exhibit 5.11 illustrates the changes in GDP across time and across scenarios. (Note: GDP growth for Scenarios 2 and 3 are so close as to be indistinguishable in the Exhibit.)

NO_X Emissions

Emissions of NO_X were estimated at 360 kt in 1985. In the Base Case, these emissions increase to 860 kt by 2010, barring introduction of any clean technologies or new abatement process/practices (see Exhibit 5.12). Because emission factors used in this model are defined as emissions per million dollars GDP, a higher GDP will result in higher emissions *ceteris paribus*. In Scenario 1, emissions rise to about 979 kt in the 2010, or 13.8% higher than in the Base Case. This difference corresponds to the differences in GDP between the cases. In Scenario 2, emissions rise to about 1001 kt in the year 2010, or about 17.6% higher than the Base Case.

The lower table in Exhibit 5.12 compares differences from the Base Case for absolute (growth-included) and for growth-adjusted emissions. As indicated, growth-adjusted emissions show very little difference for Scenarios 1 and 2, but the differences in an absolute sense -- taking growth into account -- are much more pronounced at about 14% and 18%. In short, growth appears to have more profound impacts on NO_X emissions than differences in economic structure.

Although emissions still rise significantly over the period in Scenario 3, they remain about 6% below emissions under the Base Case due to the NO_X/VOC management plan measures embedded in the Scenario. Nonetheless, the impacts of higher growth in Scenario 3 relative to the Base Case are still apparent; the benefits of environmental initiatives that are fully reflected in the decline in *growth-adjusted* emissions (19.6%) are largely offset by higher levels of absolute growth, resulting in lower emissions of only 6.4% (relative to the Base Case in 2010).

Energy Consumption

Based on constant technology (i.e. today's levels of energy efficiency in appliances, buildings, etc.), consumption of energy is expected to increase about 70%, reaching 4151 PJ annually by the year 2010.

As with NO_X emissions, higher GDP will result in higher levels of consumption. In Scenarios 1 and 2, then, consumption rises to 4724 PJ and 4048 PJ, respectively, or 13.8% and 19.2% higher than in the Base Case (see Exhibit 5.12). These increases are somewhat higher than the scenario differences in GDP due to energy-favouring differences in economic structure. Again, growth-related differences dominate scenario differences in economic structure: as shown in the table at the bottom of Exhibit 5.13, growth-adjusted differences are negligible at 0.2% and 1.3%, respectively.

The results for energy consumption in Scenario 3 correspond to those for NO_X emissions: namely, environmental initiatives aimed at reducing CO_2 emissions through energy conservation reduce both absolute and growth-adjusted emissions relative to the Base Case. However, stronger growth in Scenario 3 offsets some of the environmental efforts so that emissions on an absolute basis are only 6.7% lower than the Base Case in 2010 (compared to 20.5% lower on a growth-adjusted basis).

Summary

Economic growth has a strong effect on the levels of environmental indicators. All else equal, higher growth will increase emissions and resource use. In the examples used in this section, energy consumption and NO_X emissions at least double by the year 2010.

Growth impacts are further emphasized by the notable differences in emissions/resource use across scenarios on an absolute basis where structurally-related differences were negligible. In Scenarios 1 and 2, these absolute differences range from 14% to 19% compared with growth-adjusted differences of less than 1.5%. A 14% difference corresponds to an increase in NO_X emissions of 120 kt, or about 30% of current (1985) emissions. The implication of these results is that, in the absence of environmental regulations and/or technological change, economic growth -- not economic structure -- is likely to dominate changes in the environmental profile of the Province.

5.6 Agriculture, Land Use, Wetlands and Wildlife

Section 4 discussed the difficulty of linking measures of economic activity to certain indicators of environmental quality. These indicators were: land use, wetlands and wildlife status, and a set of measures related to agriculture.

The complexity of these linkages is due to many interdependent factors in play and to subtleties in industrial composition that are not picked up in existing economic data. For example, measures of construction activity do not characterize the type of construction undertaken even though they may have very different implications for land use requirements. For example, construction related to urbanization can be land-intensive; process/mechanical work related to implementation of environmental control technologies (as underlies the increase in construction in scenario 3) will largely be undertaken in existing plants with little or no new land requirements.

The analytical challenge is to select appropriate proxies of economic activity that can be confidently related to the environmental indicators. These indicators may or may not reside in the current inventory of information. This study passes the bulk of this challenge on to future research efforts and it limits itself to a qualitative discussion of potential impacts based on the results of the scenario analysis and model estimates of changes in the share of GDP of specific industries/sectors.

Economic Growth

The first observation of the analysis is that growth itself is likely to increase the strain on these environmental resources to a much greater degree than shifts in economic structure. Transportation, for example, doubles in size between 1990 and 2010 in all scenarios. This increased level will bring with it requirements for more infrastructure and impacts on land use and wetlands and habitat loss.[39] All scenarios, including the Base Case, embody real economic growth over the 1990-2010 period of analysis.

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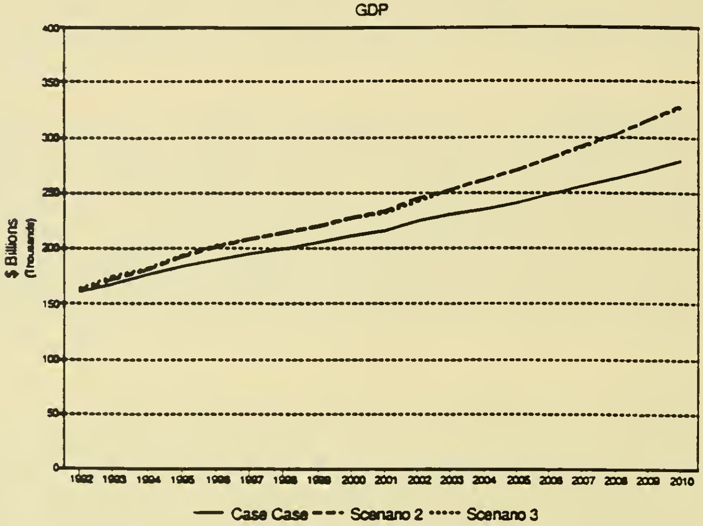
[39] In the absence of technological change and direct protective regulations.

Exhibit 5.11: Growth in GDP by Scenario 1992-2010



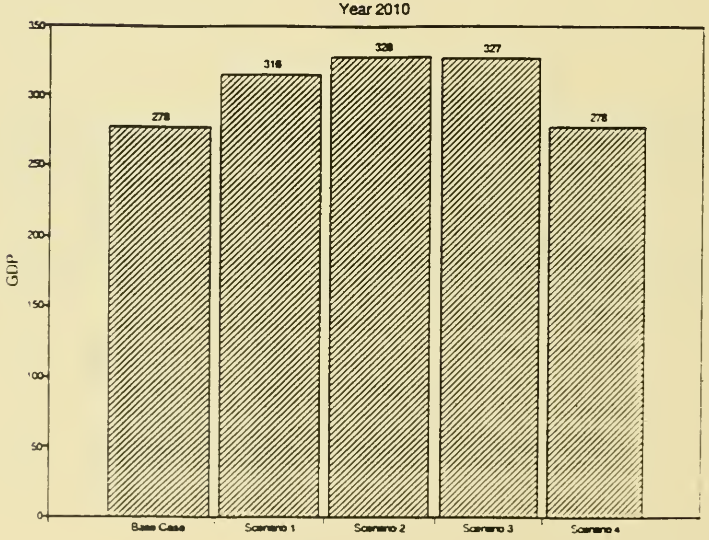
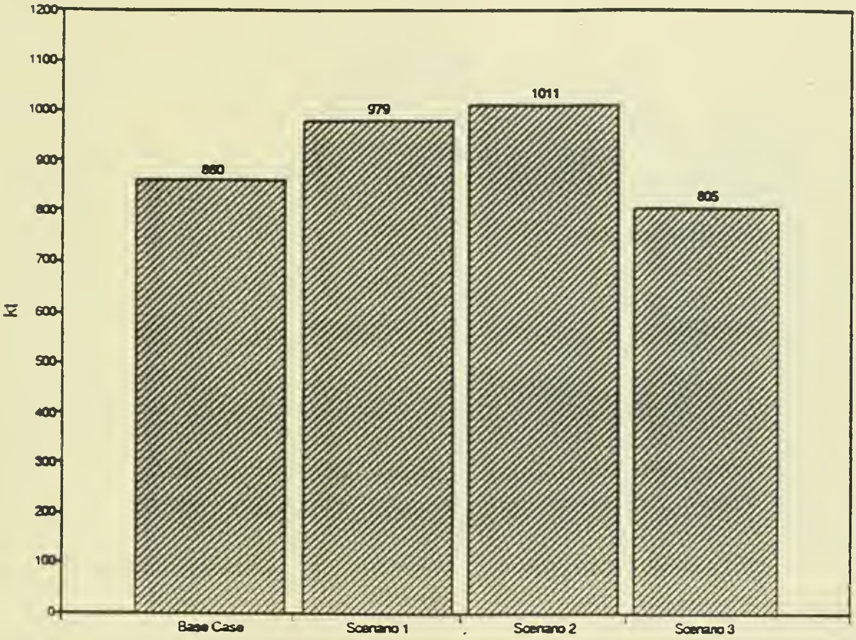


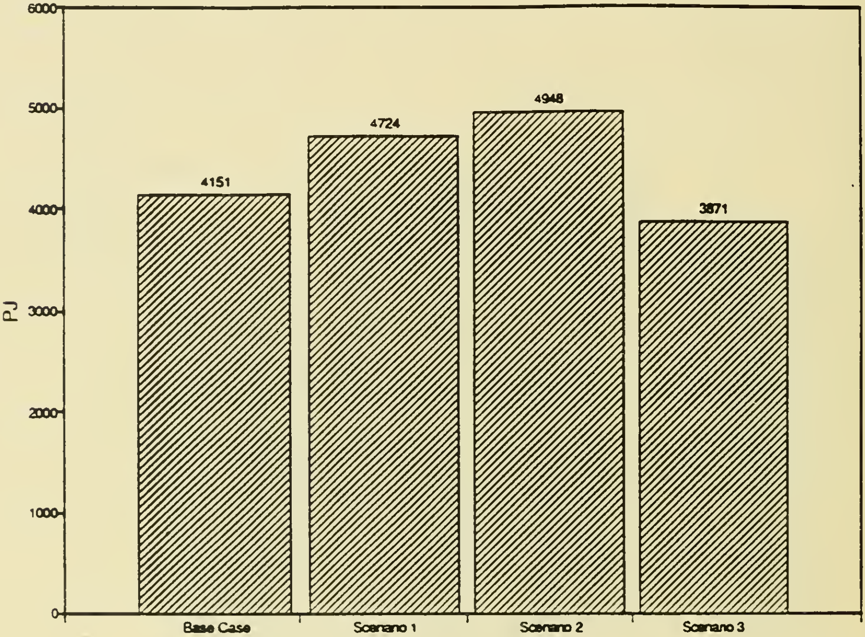
Exhibit 5.12: NOx Emissions, Year 2010



Difference from Base Case (Percent Change)		
	Absolute Levels	Growth-Adjusted*
Scenario 1	+13.8	+0.2
Scenario 2	+17.6	-0.1
Scenario 3	-6.4	-19.6

* See Exhibit 5.2

Exhibit 5.13: Energy Consumption, Year 2010



Difference from Base Case (Percent Change)		
	Absolute Levels	Growth-Adjusted*
Scenario 1	13.8	0.2
Scenario 2	19.2	1.3
Scenario 3	-6.7	-20.5

* See Exhibit 5.10

Structural Change

However, the focus of this study is the impact of *structural change*: the effect of the manner in which GDP is composed rather than the absolute levels of economic activity. The table below records shares of GDP for key sectors related to agriculture, land use, wetlands and wildlife status:

	Percent Share of GDP (Year 2010)				
Industry	**Base Case**	**Scenario 1**	**Scenario 2**	**Scenario 3**	**Scenario 4**
Agriculture	1.25%	**1.17%**	**1.14%**	**1.16%**	**1.25%**
Fishing/Trap.	0.01%	0.01%	0.01%	0.01%	0.01%
Logging	0.31%	0.31%	0.31%	0.31%	**0.20%**
Mining	1.70%	1.69%	1.71%	1.17%	**1.05%**
Construction	7.02%	6.95%	7.00%	7.07%	**8.57%**
Services	19.10%	19.26%	18.82%	18.83%	**21.41%**
Transport (road & rail)	2.94%	2.95%	2.88%	2.77%	**2.60%**

(Major changes in the shares of GDP are noted in bold.)

Agriculture

The only major share shift in Scenarios 1, 2, and 3 occurs in agriculture, which drops 6%-9% relative to the Base Case. Simplistically, one may conclude that these three scenarios reflect less stress on agricultural resources and mitigate the environmental implications associated with agricultural activity than the Base Case. However, changes in key environmental indicators for agriculture are not necessarily associated with a simple shift in GDP share. Tillage practices, pesticide use, degree of irrigation, area in fallow, etc. may improve or worsen with a change in the GDP share.

These practices and other indicators of the environmental implications of agricultural activity have become the subject of considerable concern and debate. This concern follows recognition of the degree of soil erosion, compaction, loss of soil fertility and water contamination on agricultural lands. A much more thorough analysis and assessment of the future of these practices is needed in order to predict whether agriculture-related indicators of environmental quality will improve or worsen.

The analysis undertaken in this study can only conclude that the provincial economy will use agricultural and associated environmental resources less intensively in Scenarios 1 - 3 than in the Base Case. Conclusions regarding the nature of the environmental impacts, however, cannot be made.

Scenario 4

The only other major changes in the selected sectors occur in Scenario 4 where logging, mining, and road and rail transportation lose share of GDP. These three sectors are linked with extensive land use that could directly or indirectly destroy wetlands and wildlife habitat, open access to previously undisturbed areas, contaminate surface waters and/or increase the threat of fire.

The reductions in share of GDP suggests some easing of resource stress relative to the Base Case. However, the extent to which these share shifts truly mitigate stress will be more sensitive to the regulatory context for protected areas, including:

- the degree to which land use conflicts are settled outside the price and market system;
- wilderness area set-asides;
- joint use management policies; and
- wording of endangered species regulations.

Scenario 4 is also characterized by an increase in services and "clean" high tech industries. To relate an increase in services to land use, wetlands and wildlife preservation is particularly complex. Not only do these linkages suffer the same complications alluded to several times above, but the impacts also depend on the form of expansion in the service sector, including the form of urban development.

In the latter case, a spread or core-based design for urban development could have very different implications for land use, especially for the urbanization of agricultural land. Such an analysis is beyond the scope of this study because, like the analysis of agriculture, it requires the prediction of factors that are not coincident with economic structural change.

Summary

The conclusions that can be drawn from the study's analysis of structural change regarding agriculture, land use, wetlands and wildlife preservation are limited. The analysis of other environmental indicators suggest that growth effects are likely to dominate any potential implications of structural change. Moreover, regulatory, educational and political efforts may dominate growth impacts because they directly affect many of the factors that influence the linkages between these environmental indicators and traditional measures of economic activity. This conclusion is consistent with the quantitative results of Scenario 3.

The analysis does, however, suggest that, if the patterns of regulatory and other changes are consistent across all scenarios, Scenarios 1, 2, and 3 will place less stress on agriculture-related environmental resources than the Base Case situation; and a "paradigm shift" in industrial composition, as hypothesized in Scenario 4, will reduce the array of stresses on land use, wetlands and wildlife through the diminished roles of mining, logging and road and rail transportation relative to the Base case.

5.7 Summary of the Environmental Implications of Restructuring

The purpose of this chapter was to combine environmental indicators and economic projections to examine the environmental implications of economic restructuring. The results of the various scenarios are presented numerically in Exhibit 5.14 and schematically in Exhibit 5.15. Specifically, Exhibit 5.15 plots the results detailed in Exhibit 5.14. For example, changes in air indicators in Scenario 1 range from -3% to +4% (see Exhibit 5.14) yielding the fairly short bar in the top row of Exhibit 5.15. By contrast, air indicators exhibit a much wider range of changes -- from -42% to +4% (see Exhibit 5.14) -- in Scenario 3 resulting in the much longer bar in Exhibit 5.15.

A number of observations and conclusions can be made from the scenario analysis. First, economic restructuring generated by an improved international climate and increased international trade (Scenario 1) and/or a shift in government policies to overcome weak growth and labour productivity (Scenario 2) have little impact on the intensity of the Province's use of environmental and productive resources; that is, growth-adjusted emissions and resource use changes little in either scenario relative to the Base case.

This small impact is depicted by the tight cluster of changes around zero (see Exhibit 5.15). In fact, no indicator -- be it waste generation, resource use or energy consumption -- varies by more than 8% over the Base Case and for 14 of the 22 indicators, changes are less than 2%. These results suggest that, within the realm of foreseeable external forces and domestic policy, economic structural change has little bearing on the environmental profile of the Province.

However, profound economic structural change of a scale not experienced in Canada in recent history can lead to substantial shifts in environmental indicators. This is the lesson from the results of Scenario 4, where dramatic changes in composition are seen as a "paradigm shift"; mechanisms come into play to accelerate the move away from environmentally damaging and heavy resource consuming industries to the service sector.

A second conclusion from Scenario 4 is that the resulting changes in the levels of environmental indicators vary significantly across the type of waste or resource. This is illustrated by the long bars in Exhibit 5.15 and the significant range of values given in Exhibit 5.14 for Scenario 4. Overall (and as would be expected), most environmental indicators improve; however, the shift to service-oriented activities is likely to increase the volume of solid waste generation in the absence of new, clean technologies, which may result in a failure to meet reduction targets of recently announced waste management initiatives.

The fourth observation from the preceding analysis is that environmental regulation also leads to a broad range of impacts on environmental indicators (see long bars covering a wide range of percent changes in Exhibit 5.15). The range is directly related to the comprehensiveness of environmental regulations -- 7 of the 14 waste generation indicators are the subject of environmental regulation. For these indicators growth-adjusted emissions decline dramatically. For indicators not covered by environmental initiatives, the changes are negligible.

Comparing the results for Scenario 3 and Scenario 4 raise a number of interesting observations. First, although both scenarios result in a wide range of changes in environmental indicators, the patterns are not coincident. For example, Scenario 4 generates a wider range of impacts on air emissions: growth-adjusted emissions of PM decline in Scenario 4 compared to no change in Scenario 3; and N_2O emissions increase in Scenario 3 by 44%, yet decline in Scenario 4 by 20%.

Similarly, Scenario 4 results in more notable changes in resource use. This finding is a direct result of the focus of environmental initiatives on waste generation rather than the role of extractive industries. It is also the result of the limitations of macroeconomic modelling to capture process changes to clean technologies and positive productivity feedbacks from environmental action.

In both scenarios, the indicators suggest a significant improvement in the environmental profile. The improvements in Scenario 3 are the product of environmental regulations that are stated policy in the Province. The changes in Scenario 4, by contrast, are based on a "paradigm shift" in industrial composition. The feasibility of such changes, given political and policy constraints and the role of external economic factors, is discussed in Section 6.

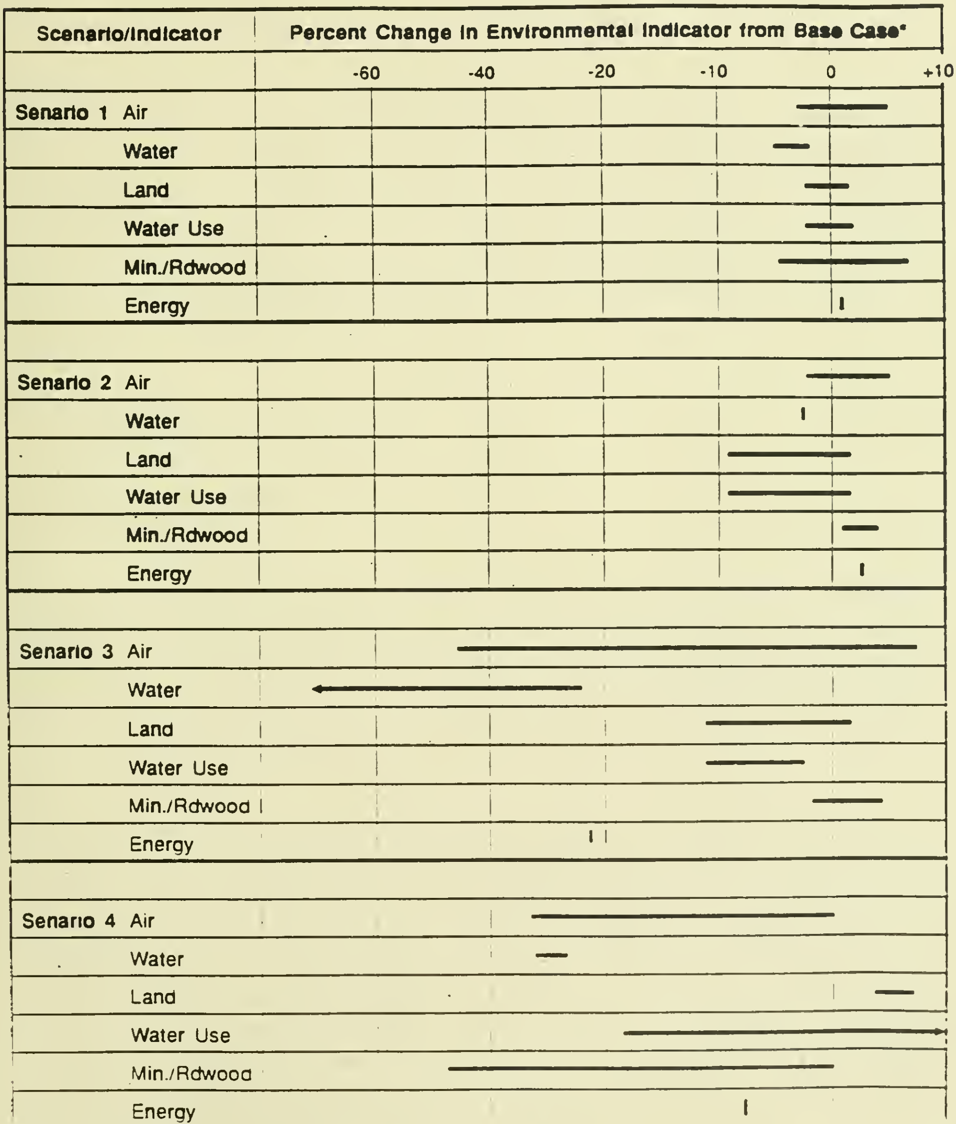
Finally, the analysis suggests that the rate of economic growth may have much more profound impacts on the environmental profile of the Province than changes in economic structure -- even of the scale imposed by Scenario 4. By way of example, absolute levels of NO_X emissions are some 14%-18% higher in Scenarios 1 and 2 relative to the Base Case even though growth-adjusted emissions are essentially the same. This difference represents an additional 120 kt of NO_X per year, or about 30% of current (1985) total emissions.

Exhibit 5.14: Summary of Changes in Growth-Adjusted Emissions and Resource Use

		Percent Change from Base Case			
Indicator		**Scenario 1**	**Scenario 2**	**Scenario 3**	**Scenario 4**
I. Waste Generation					
Air	SO_2	NC	NC	-42	-36
	CO	NC	NC	-2	-8
	PM	NC	NC	NC	-13
	NO_x	NC	NC	-20	-10
	VOC	NC	NC	-13	-9
	CO_2	+1	+1	-20	-12
	N_2O	-3	-2	+4	-20
	CH_4	+4	+4	+4	0
Water	Conv.	-1	-2	-21	-30
	Non-Conv.	-4	-2	-83	-28
	Toxics	-1	-2	-49	-31
Land	RSW	-2	-8	-8	n.a.
	Wood Waste	NC	NC	+1	+8
	Other Land Waste	NC	NC	NC	+3
II. Resource Use					
Water	Residential	-2	-8	-8	n.a.
	Commercial	NC	-1	-1	+12
	Industrial	NC	NC	-5	-17
Fertilizer		-6	-9	-8	0
Mining	Metals	NC	NC	NC	-44
	Non-metals	+5	+2	+2	-28
	Structural Materials	-3	+1	+4	0
Roundwood		NC	NC	NC	-35
III. Energy Consumption		NC	+1	-20	-6

NC = No Change

Exhibit 5.15: Schematic of Environmental Implications of Restructuring



* *Growth-Adjusted emissions, resource use or energy consumption*

6.0 POLICY IMPLICATIONS

This section of the report will discuss the environmental impact of economic policies and market forces and assess the potential for changes in economic structure.

Reviewing the analysis of the econometric model and the environmental indicators suggests that economic restructuring is a result of the complex interaction of five basic elements. The relatively small shifts in economic structure that were imposed by model simulations of new government policies and demographics suggest that these factors are less likely to impact the environment. Direct manipulation of the environmental indicators (which represents a change to new technology) had a much more dramatic effect on environmental measures. In general these findings make it likely that these elements will direct the next twenty years of restructuring in roughly the following order of importance:

- technology;
- international trade and investment;
- demographics;
- domestic savings and investment; and
- government policy.

Technology and international integration rank first because of new developments (information technology, biotechnology, trade agreements, emerging multinational corporations, etc.) that give momentum in these areas. Placing government policy last reflects the weakened fiscal position of most governments and the role of international agreements that reduce domestic autonomy. Environmental policies themselves will have an important and independent role on restructuring and this role was investigated in Scenario 3.

While government policy will not be the major influence on economic structure, the sustainability of economic development and environment quality are still tied to economic growth and structure. Thus, environmental interests are linked to the structure of the economy. One link is the extent to which the development and implementation of new technologies influences processes and products. While it is beyond the scope of this study to measure this link, it remains a critical factor in environmental structural change. The link from economic structure to the environment has been more closely examined in Chapters 3, 4 and 5 above. There are environmental benefits that are already apparent from the gradual reduction in primary industry and basic manufacturing processes that characterized the 1960s and 1970s. This report gives some hope that events in the next twenty years will continue this trend.

Traditionally, environmental policy intervenes in the existing economic structure and imposes new regulations, systems, taxes or costs. This role takes the existing structure as given. The link between economic structure and the environment highlighted here suggests a second role for environmental agencies.

An important thrust of environmental policy should be evaluating the impacts of existing and new technologies. Once the scientific evidence is collected, needed regulations or other interventions should be formulated taking into account economic considerations. Another thrust of environmental policy should be to consider the impact of other types of policy on the levels of resource use and ambient or end of pipe effects. This secondary role must take account of conflicting policy objectives such as improved trade links, lower unemployment or regional development.

This section describes the links among market conditions, economic policies and environmental conditions. There are five categories of policy that are linked to structure and environmental conditions.

6.1 Macroeconomic Policies and Growth

Over the medium term (say one to five years) the pace of economic growth can be managed by monetary and fiscal policies. These policy levers also determine, in part, the allocation of incomes between consumption and savings and the allocation of national income between the public and private sector. These broad measures are important factors determining the Province's capacity to protect the environment. In particular, heavy investments will be required to protect the environment and this, in turn, is helped by high savings levels that channel resources into capital intensive environmental initiatives. Scenario 3, discussed in Chapter 3, allocated over 80 billion ($1991) in national investment to environmental programs. Similarly, more government funds will be available for this environmental work if deficits are reduced.

These monetary and fiscal background policies might be considered as necessary but not sufficient conditions for needed environmental investments. Thus, high interest rates and/or large government deficits are clearly an obstacle to these investments. At the same time it is recognized that more capital spending will not necessarily help the environment unless the incentives and technology are available to channel activity in this direction.

It could be argued that most environmental investments are longer term assets that protect the welfare of future generations. As such these initiatives should be funded by long term borrowing by either public institutions or private interests. The best incentive for this shift in resources would be low interest rates and reduced government demand for long-term borrowing or lower current deficits. This latter requirement is consistent with higher taxes, and these might be levied on environmentally damaging activities.

In the long term environmental and resource interests are most compatible with monetary and fiscal policies that encourage savings, investing and planning for the more distant future. This orientation for macro policy would reduce economic growth and this is the surest way to minimize environmental damage for a given distribution of economic activity.

Such interests will often come into conflict with short term priorities including pressure to reduce unemployment or compensate for regional or sectoral problems. Debates over short term, cyclical considerations rarely take these environmental issues into account.

6.2 Regulatory Policy and Resource Allocation

A more fundamental question is raised in the current political preference for deregulation and privatization. This trend gained popularity in industrialized countries in the 1970s and 1980s, reflecting a renewed resolve to let markets allocate products, jobs and resources. Deregulation and private ownership spread into financial markets, transportation, energy markets and distribution, electric utilities and even education. This preference for private markets comes at an awkward time for environmental policy.

The core issue for most environmental problems is that the long term social costs of polluting or extracting are not reflected in market prices. This classic market failure requires government intervention, perhaps on an unprecedented scale, just at the time when market mechanisms are enjoying a political revival. Restructuring of the economy on the scale suggested in, for example, Scenario 4 in Chapter 3, might only be accomplished by imposing new product or resource allocations on to market solutions.

Market-based solutions are a possibility. In most of the environmental initiatives discussed in Scenario 3 some form of tax/subsidy/price mechanism is a possible alternative to command/regulate systems. From the perspective of altering behaviour and channelling resources into the required projects either method would work. The current political preference would argue that market-based systems will be more efficient in the long run.

Using price/tax/subsidies incentives at a very product or process specific level might be compatible with significant economic restructuring. These incentives would alter consumer choices, stimulate new investments, encourage technologies and alter production processes at a very micro (firm, household or institution) level. These types of incentives are not easily understood with the types of economic statistics and models that are currently available. Essentially economic structure must be studied as a broad macro matter while the core of market driven environmental policies is in the economic choices of individual units.

In any event, the current preference for deregulation and market driven systems leaves the risk that investments and processes will be introduced into the newly privatized sectors without proper accounting for environmental costs. One of the most topical areas where this conflict is now active is trade liberalization. This is discussed below.

6.3 Trade Policy, Competitiveness and Environment

One of the most pervasive and continuous elements of structural change in the Ontario economy has been the trend to greater trade and foreign investment. This change was described in Chapter 2 as a major force limiting independent, industrial policy aimed at altering industrial composition.

Environmental policies appear to come into conflict with trade liberalization as domestic governments are obliged to surrender autonomy. The power to set domestic priorities and value public goods like the environment, is reduced by trade agreements. There is a fear that such policies will be reduced to a lowest common denominator where the jurisdiction with the weakest regulations will impose the standards for all trade partners.

One of the driving forces for this change is industrial competitiveness. Trade liberalization creates new pressures to reduce costs and prices in the face of new foreign competition. As we have seen in Scenario 3, the effect of extensive environmental investment is to raise labour costs and reduce productivity.[40] Thus, increased international trade comes into conflict with environmental priorities where governments try to impose new costs that are not included in the trade partner's domestic market.

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[40] For further information on this topic see the recent report by Apogee Research "Environmental Protection Measures, Competitiveness and Productivity" prepared for the Ministry of the Environment, November, 1991.

Analysis in Scenarios 2 and 3 provide some idea of the extent of this effect. In Scenario 3 we imposed an $80 billion ($33 billion in Ontario) investment and regulation program that was designed to implement a wide range of environmental initiatives. This spending was distributed across many industries and government programs between 1992 and 2000. All of this investment and spending was imposed on the Scenario 2 results which featured relatively strong growth and improved productivity performance. The environmental investments are all targeted on conserving resources or reducing waste/emissions. None of these effects are captured in the conventional measures of output. Thus the usual productivity measures of output per worker are reduced by this new spending. This implies a loss of competitiveness relative to foreign producers who are not implementing the same environmental initiatives.

It turns out that the impact on aggregate productivity is not large. By the year 2000 and during the next decade productivity is reduced by less than 1%, unit labour costs are increased by 2% and exports are reduced by between 1 and 2%. Given the deliberately large and aggressive magnitude of the environmental effort, this seems to be a small impact.

The aggregate impact, however, might be a misleading indicator for individual industries. There is a very narrow distribution of investment spending and regulatory impacts for the Scenario 3 environmental program. Major changes in production processes (and associated loss of productivity) were concentrated in non-ferrous metals, steel production, pulp and paper production, some food processing sectors, industrial chemicals, petroleum refining and truck/commercial vehicle transportation (see Exhibit 6.1 for investment details). In these sections the loss of productivity would be more severe.

This focus on labour productivity is a rather narrow interpretation of costs and a short term orientation to trade can create significant ecological problems. A broader view would include recognizing the true long term efficiencies related to waste reduction and resource conservation. For example, a long term industrial policy that recognizes environmental costs immediately would create trade benefits in the future when competing jurisdictions have exhausted resources and polluted the environment.

Chapter 5 referred to a series of targeted improvements in environmental indicators that would be associated with the investment and regulation program. These gains must be weighed against the loss of productivity noted above. End of pipe improvements, of the type described in Scenario 3, would lead to improvements in ambient or quality of life indicators. These improvements have direct benefits through (for example) lower health care costs. The more deeply environmental restructuring can penetrate into consumer purchases or industrial processes, the greater these long run quality of life benefits will be.

While the available statistics and models cannot measure these effects, they suggest a scenario of cumulative benefits. This scenario might be seen as an extension of either Scenario 3 or 4. In either case environmental restructuring, begun in the 1991-2000 period would fuel a virtuous cycle of benefits. Direct effects noted above would give Ontario a higher quality of life that would represent a competitive advantage in attracting skilled workers and investment. The policy trade-off would involve a temporary increase in unit costs as noted above for a longer term gain in quality of life.

Our research gives a sense of the magnitude of these trade-offs. The Scenario 3 programs are shown to imply a relatively modest, short term reduction in competitiveness. At the same time these initiatives create specific reductions in emission factors that range from zero to over fifty percent. This is only the direct benefits and costs. Active environmental restructuring of the type included in Scenario 3 would create indirect benefits through reduced long term health costs and an improved quality of life. Investigating the extent of these impacts is the next step in considering economy wide policy options related to environmental restructuring.

This longer term vision is part of the Ontario Industrial Policy Framework that focuses on environmental improvement and building a highly skilled and highly paid workforce. This vision would extend to building a strong domestic environmental protection industry.

6.4 Industrial Policy and Environmental Protection Industries

Ontario's industrial policy framework recognize a special role for environmental protection industries. There are many potential benefits associated with this integration of industrial and environmental policy. At the same time there are potential conflict of interests.

Considerable attention has been focused on the potential for the Ontario environmental protection industry.[41] Global attention to the enormous scope and complexity of environmental protection make it clear that this is a growth market. Government regulations and procurement will certainly play a major role in determining the timing and nature of demands. There are already examples of companies that have grown to international stature by supplying high tech solutions to environmental problems. The appeal of combining high tech jobs, global markets and environmental benefits is very strong.

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[41] Comments included here reflect the results and implications of the Informetrica model simulations and analysis of Ontario's environmental protection industry. The reader should also refer to the recent Ernst and Young report "Study of the Ontario Environmental Protection Industry", completed for the Ministry of the Environment in May, 1992. Several earlier provincial and national studies have documented the size, growth and potential for this industry.

This study offers some evidence on the potential for such a policy. Certainly it is expected that major environmental initiatives would have some impact on the structure of the economy and on the size and distribution of some businesses. How might industrial activity be affected by environmental initiatives and is there a role for a provincial industrial policy? The discussion of Scenario 3 reviewed the impacts of direct spending required and the induced activity in Ontario sectors in Exhibits 3.32 and 3.33. It showed that the major industries that benefit from the environmental investments are the construction, electrical equipment and business services sectors.

This view of the environmental protection sector provides several suggestions about the need for an industrial policy. First, the breakdown of required industry outputs shows relatively little emphasis on high technology sectors. Most of the components of the environmental investment are conventional, low tech, building materials. Second, it is clear that the spending would be concentrated in the 1990s and that demand would dissipate later. Additions to provincial capacity to supply the investment boom of the 1990s would need to make provisions for new, foreign markets in the later periods. These observations would seem to reduce the attractiveness of a policy initiative to assist the broad base of businesses that would participate. However, this evidence does not consider the benefits of a more focused policy on new or specialized environmental technologies.

The province has already indicated a direction for industrial policy that emphasizes the development of high value added, manufacturing industries. Such a policy would likely complement environmental initiatives.

Finally, provincial regulations themselves have an impact on economic structure and environmental impacts. Provinces have pursued various types of industrial policies that have targeted certain kinds of industrial development. The classic Canadian formula is the aggressive creation of extensive, low cost electricity facilities to attract energy intensive industry. This strategy has obvious, negative environmental impacts as it attracts the very industries (chemicals, primary metals and metal fabricating) that have the largest environmental impact. Ontario has followed this trend on its own and as a consequence of national priorities. Certainly the 1965

Auto Pact, the National Energy Policy and the incentives for the Candu reactors are all examples of industrial policies that shaped Ontario's industrial structure.

6.5 Environmental Quality and Economic Welfare

The study highlights the importance of overall economic growth rather than structure as a key determinant of environmental quality. Both over history and in the foreseeable future, the expansion of activity will likely include the expansion (although perhaps at a slower than average pace) of resource and waste/emissions generating activities. If we set aside the potential benefits of specific new technologies that will reduce waste or resource use in particular processes or products, then it is clear that growth itself will create pressure on resource stocks or environmental quality.

Economics is a science of flows; studying the allocation of incomes, production, trade and investment. These flows are all seen as reversible in economics - recessions follow expansions and resources allocated to one industry or country can be reallocated later. Even the "stocks" of factors of production, labour and capital, are flexible in the long run as training and investment can redirect these stocks in the long run. Truly fixed and non-renewable factors such as natural resources, land and the environment are not well integrated into economic models.

Government policies are often set to manage flows and satisfy demands, perhaps for needs that fall outside the market. Both the economic system and government policy do not recognize the irreversible link between long term economic growth and the environment. Resource depletion and environmental contamination are irreversible. It is not enough to slow down the rate of circulation of economic activity because each year's production leaves waste or depletes resources. Slower economic growth is the most direct response to accumulating environmental costs. Restructuring is a second order response as we have seen that shifts in industrial composition are unlikely to reduce the absolute level of annual waste generation and resource consumption.

These considerations seem to suggest a trade-off between environmental protection and short-term economic policies. While these may present short term conflicts of the type described here, in the long term there is no contradiction. The issue is only the proper policies and mechanisms to include both in decision making.

Thus there is a real environmental interest in the management of economic policies that are designed to create or contain growth. This involvement in growth strategies is at least as important as managing structural change.

The interests of provincial environmental policies in trade relationships are also important. In particular, trade creates the potential for conflict and the need for reconciliation of environmental policies. For example, Ontario is the unwilling recipient of acid rain related to energy policies in other jurisdictions that do not recognize the full environmental costs of energy use. An industrial policy in Ontario that deliberately reduced the share of (say) primary metal industries, should be seen as simply exporting this production process to the jurisdictions with lax energy policies. Ontario then imports metal products (and acid rain) as part of a new environmental restructuring. Essentially, this restructuring process does not improve the quality of the environment for the continent and perhaps not even for Ontario. The realities of trade and the pervasive reach of environmental damage both limit the scope of "environmental restructuring".

Environmental restructuring, then, is not really a policy option for a single jurisdiction like Ontario. It is more like an international and technological process. The environmental implications of restructuring can be understood, and to some extent managed, through the analysis of trade flows, international investment trends and new technological developments. Where provincial policies can influence these factors, they can have an influence on the environment.

In this regard, the draft NAFTA agreement may provide a vision of continental environmental restructuring. Domestic policies can shape and leverage restructuring, but such efforts make most sense in the broader context of continental or international changes. This means, for example, one jurisdiction's decision to discourage steel production should be balanced by another jurisdiction's plan to encourage steel production under agreed environmental constraints. Without this balanced approach, individual policies will provoke trade complaints or retaliation.

7.0 CONCLUSIONS AND RECOMMENDATIONS FOR FUTURE RESEARCH

The structure of the Ontario economy has been shifting steadily for at least twenty years from primary and manufacturing industries to service activities. This shift is seen as a consequence of the following major structural factors -- demographics, international conditions, domestic government policy, resource endowments, technological change and patterns of investment and savings. In a Base Case and four alternative forecast scenarios of the next twenty years, the study projects various extensions of this structural shift. Each forecast for industrial sectors is linked to a set of environmental indicators that measure resource use and emissions.

Projections made with an econometric model showed a continuing trend to more service activity and this shift was not easily accelerated or retarded by different demographics, government policies or international growth. In general, the results show that environmental impacts, in the form of increased resource use and more waste, will continue to grow. A greater structural shift from primary to service activities will alter the composition of resource use and waste more than reduce the overall quantity.

Based on the model simulations, provincial environmental policies will likely have a limited effect on the structure of the economy. Market forces and growing international trade limit the potential for any kind of government polices to affect the long term evolution of economic structure. Of the key structural factors, technological change appears to be the most powerful determinant of both economic structure and environmental quality in the longer term.

The analysis of structural change in the Ontario economy indicates that industrial composition will evolve slowly and will resist variations in demography, international demand, labour productivity and other factors. Trade and market forces appear to allocate employment and production to the current configuration of industries with only gradual changes. These observations may be biased by the structure of the statistics and the models used. The very nature of statistical collection and model building is designed to capture and reproduce the past structure of the economy.

A simulation of a significant shift in industrial composition (Scenario 4) from primary industries (mining, forestry, agriculture and primary manufacturing) to services (finance, insurance, retail trade, business services) showed the potential for environmental benefits. Under these circumstances, there is a shift in the composition of environmental impacts away from emissions to air (in particular SO2 emissions) towards emissions to land. It seems that the service sectors generate solid waste that will place more stress on land fill and other disposal systems. This evidence suggests that a change in industrial composition will alter the mix of waste and resources use.

The report dramatizes a series of policy trade-offs. As one type of pollution is substituted for another it becomes clear that environmental initiatives and priorities need to be altered. For example, the controversy around energy from waste and incineration grows more important while acid rain concerns diminish.

Major investments in environmental improvement will be encouraged by macroeconomic policies that emphasize low interest rates and reduced government deficits. The apparent importance of technology, relative to other factors driving industry structure, implies that one important role for environmental policy is the management and promotion of sound new technologies and related policies.

Domestic economic growth, immigration and incentives for business expansion are set against technological preferences to clean products and processes. Rapid economic growth is seen in this work to be the ultimate concern. Slow growth, allowing time to adapt new technologies, becomes an important priority.

To evaluate these policy alternatives, it is important to have detailed environmental indicators that capture both the role of economic structure (i.e. cover all economic sectors) and technology (i.e. changes in resource use or emissions). Limitations on the coverage and on the quality of data make policy interpretations difficult. The "end of pipe" measures used in this study help to specify the nature and distribution of impacts. The next generation of indicators should extend to ‘ambient’ measures that calculate the damage imposed on the environment and the associated social costs.

A remaining challenge is the creation of a data set, economic model and environmental indicators that combine long term technological capabilities and economic structure in long term forecasts. This sort of system would permit simulations of alternative types of technological advance that reduce emissions, conserve resources, improve labour efficiency, etc. Policy analysis could then focus on benefits and costs.

This research and report have created a system of models, indicators, tables and graphics that can be applied to new problems and issues. In fact, the scenarios studied here could be adapted or altered to consider more types of change. This might involve either broad economic simulations or simple alternative industrial compositions in the future.

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Glossary of Terms

Ambient
Referring to quantitative or qualitative measures of the impacts of pollution or emissions from economic activity measured once they have dispersed into the air, water or land. Also referred to as stress indicators.

CO
Carbon Monoxide

CO_2
Carbon Dioxide

Deindustrialization
Referring to the trend across industrialized countries for economic activity, most commonly measured by employment, to shift away from traditional primary activities such as mining, forestry, agriculture and primary manufacturing (e.g. metal fabricating) towards service activities.

Dematerialization
A term used in the 1991 OECD study "The State of the Environment" with reference to the observed trend to production of various industrial products with smaller quantities of traditional materials such as glass, steel and paper.

Econometric Models
Models of an economic system (market, region, production process) based on a series of linked equations. Equations are built up by regression analysis of time series or cross section data. These models can be used for projections and simulations.

End of Pipe
Referring to quantitative measures of pollution and emissions related to economic activity where the output is measured at the source.

Environmental Indicators
Measures constructed for in this study as the ratio of environmental outputs (either emission quantities or resource use) divided by Gross Domestic Product in 1981$. These measures refer to environmental measures (e.g. tons of SO_2 emissions) and industries (e.g. steel output).

Environmental Restructuring
Refers to the development of the economy in a manner that supports the sustainable use of resources.

Glossary of Terms (cont)

Growth Adjusted
The comparison of emission levels and resource use across scenarios is adjusted to eliminate the effects of overall economic growth (technically emission levels are divided by real GDP) to focus on the impacts of structural change (shifts in industrial composition) in the economy.

IC&I
Industrial, Commercial and Institutional

NOX
Oxides of Nitrogen

PM
Particulate Matter

Productivity
A measure of physical output per unit of input. High productivity measures indicate more efficient use of the input. The most common use of the term refers to labour productivity -- the quantity of output gained per unit of labour input.

Quality of Life
Referring to measures of social and economic well being such as health, recreation, literacy, education or climate standards.

Scenarios
Referring to annual projections of various economic and environmental measures, generated with the Informetrica model and related time series on industry output, covering the period 1992 to 2011 and linked to the Base Case projections through the manipulation of exogenous variables.

SIC
Standard Industrial Classification

SO_2
Sulphur Dioxide

Structural Change
In general this term refers to long term shifts in various features of the economy including the composition of the labour force, employment, resource endowments, income distributions, trade patterns and capital stock. For purposes of this study structural change is defined as the change in the distribution of industrial Gross Domestic Product measured in 1981 $.

Sustainable Development
Referring to the quantitative and qualitative expansion of economic activity at a rate that is consistent with maintaining the physical and natural capital stock and preserving the quality of the environment for the longer term.

Glossary of Terms (cont)

Sustainable Yield
Referring to the rate of production or harvesting of renewable natural resources (e.g. trees, fish, game) at a rate that maintains a constant stock.

Technological Change
Referring to change in the manner or the equipment that is used to combine inputs and generate outputs in a production process. Such change might alter either the efficiency (productivity) of the process or the quality or features of the output.

VOC
Volatile Organic Compounds

Appendix I

Environmental Indicators

INDICATORS OF WASTE GENERATION - AIR POINT SOURCES

(PM, SO_2, NO_X, VOC, CO)

INDICATORS OF WASTE GENERATION -- AIR

POINT SOURCE EMISSIONS OF PARTICULATES, SO2, NOX, VOC'S AND CO.

SIC 1980 Code	SECTOR NAME	PM Tonne/Year 1985	SO2 Tonne/Year 1985	NOx Tonne/Year 1985	VOC Tonne/Year 1985	CO Tonne/Year 1985
	Business					
011-023	Agriculture and Related Services	--	--	--	--	--
031-033	Fishing and Trapping	--	--	--	--	--
041-051	Logging and Forestry	--	--	--	--	--
061-092	Mining - Total Extraction	--	--	--	--	--
061-062	Mining (Metals & Non-Metals)	--	--	--	--	--
061	Metal Mining	7,275.4	--	928.5	3.0	--
0611-0616,0	Metal Mining (Excl. Iron)	--	14,219.2	672.5	2.0	0.7
0617	Mining -- Iron	2,857.4	115,890.0	256.0	1.0	47,525.5
062-063	Non-Metal Mining & Coal	--	--	--	--	--
062	Non-Metal Mining	--	432.9	260.9	10.4	9.2
063	Mining -- Coal	--	--	--	--	--
064	Mining - Crude Petroleum & N.G.	--	--	--	--	--
081-082	Mining - Quarry & Sand Pit	--	--	--	--	--
091-092	Mining - Services	--	--	--	--	--
401-449	Construction - Total	--	--	--	--	--
451-479	Transportation & Storage (DIV G)	--	--	--	--	--
451-459	Transportation - Total	--	180.9	182.8	9.4	--
451-452	Transportation - Air	--	--	--	--	--
453	Transportation - Railway	--	--	--	--	1.3
454-455	Transportation - Water	--	--	--	--	--
456-459	Transportation - Motor & Misc.	--	--	--	--	--
456	Transportation - Motor - Truck	--	--	--	--	--
457-459	Transportation - Motor - Other	--	78.2	137.7	8.5	43.2
461	Transportation - Pipeline	--	--	--	--	--
471-479	Storage and Warehousing	--	--	--	--	0.2
481-499	Communications & Utilities (Div H)	--	--	--	--	--
481-484	Communication - Total	--	--	--	--	--
481	Communication - Radio TV Cable	--	--	--	--	--
482-483	Communication - Carriers & Other	--	--	--	--	--
484	Communication - Postal	--	--	--	--	--
491-499	Utilities - Total	201,163.5	--	--	--	--
491	Utilities - Electric Power	--	336,665.0	94,542.0	440.0	3,310.7
492	Utilities - Gas	--	531.0	446.0	1.0	12.7
493-499	Utilities - Water & Other	--	372.0	664.0	411.0	4,899.0

INDICATORS OF WASTE GENERATION -- AIR

POINT SOURCE EMISSIONS OF PARTICULATES, SO2, NOX,
VOC'S AND CO.

SIC 1980 Code	SECTOR NAME	PM Tonne/Year 1985	SO2 Tonne/Year 1985	NOx Tonne/Year 1985	VOC Tonne/Year 1985	CO Tonne/Year 1985
501-692	Trade - Total Wholesale/Retail	--	--	--	--	--
501-559	Trade - Wholesale	--	--	--	--	--
601-692	Trade - Retail	--	--	--	--	3.7
701-761	Fin, Insur, Real Est. - Total	--	95.0	40.0	--	--
701-749	Finance - Personal	--	78.0	28.0	1.0	1.1
--	Finance - Royalties + Imputed	--	--	--	--	--
--	Finance - Govt Royalties	--	--	--	--	--
--	Fin - Owner Ocupied Dwellings	--	--	--	--	--
771-999	Community Business & Pers Serv	0.0	--	--	1,989.5	--
771-779	Services - Business	--	--	4,996.8	--	--
779	Other Business Services	--	--	--	--	--
775-779	Professional Business Services	--	6,395.6	4,887.8	811.5	0.4
774	Advertising Services	--	57.0	94.0	2.0	--
851-859	Services - Education	--	1,093.0	595.0	23.0	51.0
861-869	Services - Health & Social	--	--	--	--	--
861	Services - Health - Hospitals	--	5,246.0	4,199.0	786.0	109.2
862-869	Services- Health - Phys & Oth H	--	57.0	94.0	2.0	--
911-922	Services - Accomm & Food	--	92.0	50.0	1.0	1.5
961-999	Other Services (Div R)	--	380.0	262.0	364.0	927.1
961-969	Services - Recreation & Amusement	--	--	1.0	--	0.1
971-999	Services - Personal	--	190.0	130.0	182.0	463.3
811-841	Public Administration - Total	--	--	359.0	--	--
811-817	Public Admin - Fed & Defence	--	--	--	--	--
811	Public Admin - Defence	--	150.0	180.0	7.0	16.6
812-817	Federal Government Services	--	236.0	95.0	82.0	111.2
822-827	Public Administration - Prov	--	--	--	--	--
832-837	Public Administration - Local	--	45.0	84.0	1.0	2.6

INDICATORS OF WASTE GENERATION -- AIR

POINT SOURCE EMISSIONS OF PARTICULATES, SO2, NOX,
VOC'S AND CO.

SIC 1980 Code	SECTOR NAME	PM Tonne/Year 1985	SO2 Tonne/Year 1985	NOx Tonne/Year 1985	VOC Tonne/Year 1985	CO Tonne/Year 1985
	MANUFACTURING					
--	Manufacturing - Total	--	--	--	--	--
101-109	Food Prod. - Total (Excl. Beverages)	26.0	--	--	--	--
102	Food Production - Fish	0.1	--	--	0.1	--
101,103-109	Food Prod. - Other than Fish	--	1,073.0	1,988.0	1,198.9	131.7
111-114	Beverages	--	210.0	521.0	811.0	35.9
121-122	Tobacco	--	23.0	17.0	1.0	1.4
151-159	Rubber	--	185.0	385.0	2,698.0	19.5
161-169	Plastic	--	--	--	--	--
171	Leather	--	2.0	170.0	57.0	34.1
181-199	Primary Textiles & Textile Products	--	7,158.0	1,364.0	1,647.0	4,492.0
243-249	Garments and Clothing	--	--	--	--	--
251-259	Wood	--	7.0	88.0	44.0	651.1
261-269	Furniture	--	--	--	--	--
271-279	Paper & Allied- Total	--	--	--	--	--
271	Paper & Allied- Pulp & Paper	20,409.0	29,447.0	11,487.0	2,076.0	37,694.0
272-279	Paper & Allied- Paper Conv	--	163.0	226.0	4,125.0	4.0
281-284	Printing & Publishing	--	27.0	66.0	244.0	4.6
291-299	Primary Metal - Total	--	--	--	--	--
291-294	Primary Metal - Iron and Steel	9,402.4	26,165.0	13,882.0	5,471.0	205,202.5
295-299	Primary Metal - Non-Ferrous	16,076.1	769,497.0	4,979.0	47.0	163.0
301-309	Metal Fabrication - Total	--	2,596.0	638.0	1,481.0	114.5
311-319	Machinery (Excl. Electrical) - Total	--	2,298.0	271.0	1,145.0	11.5
321-329	Transportation Equipment - Total	--	1,802.0	1,994.0	3,539.0	499.7
323	Transportation Equip. - Motor Vehicle	--	1,239.0	1,128.0	1,949.0	453.8
321	Transportation Equip. - Aircraft etc.	--	--	21.0	--	1.6
326,329	Railroad Rolling Stock & Misc.	--	113.0	148.0	174.0	16.3
327-328	Transportation Equip. - Shipbuilding	--	--	--	--	--
331-339	Electrical Equipment - Total	--	323.0	302.0	134.0	15.0
351-359	Non-Metallic Mineral - Total	13,220.5	24,011.0	10,533.0	3,684.0	176.0
351,354-355	Non-Metallic Cement & Clay Production	391.5	17.0	705.0	2,165.0	49.2
356	Non-Metallic - Glass	--	702.0	1,576.0	13.0	36.0
361-369	Petroleum & Coal- Total	--	60,614.0	17,687.0	13,604.0	46,068.3

INDICATORS OF WASTE GENERATION -- AIR

POINT SOURCE EMISSIONS OF PARTICULATES, SO2, NOX,
VOC'S AND CO.

SIC 1980 Code	SECTOR NAME	PM Tonne/Year 1985	SO2 Tonne/Year 1985	NOx Tonne/Year 1985	VOC Tonne/Year 1985	CO Tonne/Year 1985
371-379	Chemicals - Total	--	--	--	--	--
371	Chemicals - Industrial	18,231.0	3,931.0	3,002.0	3,664.0	2,574.8
372-379	Chemicals - Non-Industrial	2,338.6	6,022.0	11,573.0	11,305.0	1,394.0
391-399	Manufacturing - Other Misc.	--	8.0	65.2	659.0	115.0

POINT SOURCE EMISSIONS OF PARTICULATES, SO2, NOX, VOC'S AND CO.

SIC 1980 Code	SECTOR NAME	PM Tonnes Per M$ RDP 1985	SO2 Tonnes Per M$ RDP 1985	NOx Tonnes Per M$ RDP 1985	VOC Tonnes Per M$ RDP 1985	CO Tonnes Per M$ RDP 1985
491-499	Utilities - Total	58.9542	--	--	--	--
491	Utilities - Electric Power	--	128.2680	36.0201	0.1676	1.2614
492	Utilities - Gas	--	1.1556	0.9706	0.0022	0.0276
493-499	Utilities - Water & Other	--	1.1341	2.0244	1.2530	14.9359
501-692	Trade - Total Wholesale/Retail	--	--	--	--	--
501-559	Trade - Wholesale	--	--	--	--	--
601-692	Trade - Retail	--	--	--	--	0.0004
701-761	Fin, Insur, Real Est. - Total	--	0.0053	0.0022	--	--
701-749	Finance - Personal	--	0.0075	0.0027	0.0001	0.0001
--	Finance - Royalties + Imputed	--	--	--	--	--
--	Finance - Govt Royalties	--	--	--	--	--
--	Fin - Owner Ocupied Dwellings	--	--	--	--	--
771-999	Community Business & Pers Serv	--	--	--	0.0730	--
771-779	Services - Business	--	--	0.9869	--	--
779	Other Business Services	--	--	--	--	--
775-779	Professional Business Services	--	2.5369	1.9388	0.3219	0.0002
774	Advertising Services	--	0.1801	0.2969	0.0063	--
851-859	Services - Education	--	0.1568	0.0853	0.0033	0.0073
861-869	Services - Health & Social	--	--	--	--	--
861	Services - Health - Hospitals	--	1.7124	1.3707	0.2566	0.0356
862-869	Services- Health - Phys & Oth H	--	0.0131	0.0216	0.0005	--
911-922	Services - Accomm & Food	--	0.0316	0.0172	0.0003	0.0005
961-999	Other Services (Div R)	--	0.0777	0.0536	0.0745	0.1896
961-969	Services - Recreation & Amusement	--	--	0.0008	--	0.0001
971-999	Services - Personal	--	0.0515	0.0352	0.0493	0.1256
811-841	Public Administration - Total	--	--	0.0454	--	--
811-817	Public Admin - Fed & Defence	--	--	--	--	--
811	Public Admin - Defence	--	0.1627	0.1952	0.0076	0.0180
812-817	Federal Government Services	--	0.0806	0.0325	0.0280	0.0380
822-827	Public Administration - Prov	--	--	--	--	--
832-837	Public Administration - Local	--	0.0207	0.0387	0.0005	0.0012

INDICATORS OF WASTE GENERATION -- AIR

Environment - Economy Linkages

POINT SOURCE EMISSIONS OF PARTICULATES, SO2, NOX,
VOC'S AND CO.

SIC 1980 Code	SECTOR NAME	PM Tonnes Per M$ RDP 1985	SO2 Tonnes Per M$ RDP 1985	NOx Tonnes Per M$ RDP 1985	VOC Tonnes Per M$ RDP 1985	CO Tonnes Per M$ RDP 1985
	Business					
011-023	Agriculture and Related Services	--	--	--	--	--
031-033	Fishing and Trapping	--	--	--	--	--
041-051	Logging and Forestry	--	--	--	--	--
061-092	Mining - Total Extraction	--	--	--	--	--
061-062	Mining (Metals & Non-Metals)	--	--	--	--	--
061	Metal Mining	3.9598	--	0.5054	0.0016	--
0611-0616,0	Metal Mining (Excl. Iron)	--	8.0916	0.3827	0.0011	0.0004
0617	Mining -- Iron	35.6983	1447.8475	3.1983	0.0125	593.7499
062-063	Non-Metal Mining & Coal	--	--	--	--	--
062	Non-Metal Mining	--	6.3335	3.8171	0.1522	0.1346
063	Mining -- Coal	--	--	--	--	--
064	Mining - Crude Petroleum & N.G.	--	--	--	--	--
081-082	Mining - Quarry & Sand Pit	--	--	--	--	--
091-092	Mining - Services	--	--	--	--	--
401-449	Construction - Total	--	--	--	--	--
451-479	Transportation & Storage (DIV G)	--	--	--	--	--
451-459	Transportation - Total	--	0.0352	0.0355	0.0018	--
451-452	Transportation - Air	--	--	--	--	--
453	Transportation - Railway	--	--	--	--	0.0018
454-455	Transportation - Water	--	--	--	--	--
456-459	Transportation - Motor & Misc.	--	--	--	--	--
456	Transportation - Motor - Truck	--	--	--	--	--
457-459	Transportation - Motor - Other	--	0.0519	0.0915	0.0056	0.0287
461	Transportation - Pipeline	--	--	--	--	--
471-479	Storage and Warehousing	--	--	--	--	0.0012
481-499	Communications & Utilities (Div H)	--	--	--	--	--
481-484	Communication - Total	--	--	--	--	--
481	Communication - Radio TV Cable	--	--	--	--	--
482-483	Communication - Carriers & Other	--	--	--	--	--
484	Communication - Postal	--	--	--	--	--

INDICATORS OF WASTE GENERATION -- AIR

Environment - Economy Linkages

POINT SOURCE EMISSIONS OF PARTICULATES, SO2, NOX, VOC'S AND CO.

SIC 1980 Code	SECTOR NAME	PM Tonnes Per M$ RDP 1985	SO2 Tonnes Per M$ RDP 1985	NOx Tonnes Per M$ RDP 1985	VOC Tonnes Per M$ RDP 1985	CO Tonnes Per M$ RDP 1985
	MANUFACTURING					
--	Manufacturing - Total	--	--	--	--	--
101-109	Food Prod. - Total (Excl. Beverages)	0.0085	--	--	--	--
102	Food Production - Fish	0.0101	--	--	0.0101	--
101,103-109	Food Prod. - Other than Fish	--	0.3509	0.6501	0.3921	0.0431
111-114	Beverages	--	0.2721	0.6750	1.0507	0.0465
121-122	Tobacco	--	0.2352	0.1738	0.0102	0.0143
151-159	Rubber	--	0.2658	0.5532	3.8770	0.0280
161-169	Plastic	--	--	--	--	--
171	Leather	--	0.0066	0.5622	0.1885	0.1127
181-199	Primary Textiles & Textile Products	--	8.6158	1.6418	1.9824	5.4069
243-249	Garments and Clothing	--	--	--	--	--
251-259	Wood	--	0.0102	0.1286	0.0643	0.9512
261-269	Furniture	--	--	--	--	--
271-279	Paper & Allied- Total	--	--	--	--	--
271	Paper & Allied- Pulp & Paper	17.4914	25.2374	9.8449	1.7792	32.3054
272-279	Paper & Allied- Paper Conv	--	0.2546	0.3530	6.4423	0.0063
281-284	Printing & Publishing	--	0.0137	0.0336	0.1241	0.0023
291-299	Primary Metal - Total	--	--	--	--	--
291-294	Primary Metal - Iron and Steel	4.1075	11.4303	6.0644	2.3900	89.6433
295-299	Primary Metal - Non-Ferrous	26.0426	1246.5528	8.0658	0.0761	0.2641
301-309	Metal Fabrication - Total	--	0.8639	0.2123	0.4928	0.0381
311-319	Machinery (Excl. Electrical) - Total	--	1.3603	0.1604	0.6778	0.0068
321-329	Transportation Equipment - Total	--	0.2581	0.2856	0.5070	0.0716
323	Transportation Equip. - Motor Vehicle	--	0.1981	0.1804	0.3117	0.0726
321	Transportation Equip. - Aircraft etc.	--	--	0.0476	--	0.0036
326,329	Railroad Rolling Stock & Misc.	--	0.4734	0.6200	0.7290	0.0685
327-328	Transportation Equip. - Shipbuilding	--	--	--	--	--
331-339	Electrical Equipment - Total	--	0.0715	0.0668	0.0296	0.0033
351-359	Non-Metallic Mineral - Total	12.3973	22.5159	9.8772	3.4546	0.1651
351,354-355	Non-Metallic Cement & Clay Production	0.5464	0.0237	0.9839	3.0214	0.0687

INDICATORS OF WASTE GENERATION -- AIR

Environment - Economy Linkages

POINT SOURCE EMISSIONS OF PARTICULATES, SO2, NOX, VOC'S AND CO.

SIC 1980 Code	SECTOR NAME	PM Tonnes Per M$ RDP 1985	SO2 Tonnes Per M$ RDP 1985	NOx Tonnes Per M$ RDP 1985	VOC Tonnes Per M$ RDP 1985	CO Tonnes Per M$ RDP 1985
356	Non-Metallic - Glass	--	2.0066	4.5049	0.0372	0.1028
361-369	Petroleum & Coal- Total	--	407.6261	118.9442	91.4862	309.8068
371-379	Chemicals - Total	--	--	--	--	--
371	Chemicals - Industrial	26.5836	5.7320	4.3774	5.3427	3.7545
372-379	Chemicals - Non-Industrial	1.1866	3.0555	5.8719	5.7360	0.7073
391-399	Manufacturing - Other Misc.	--	0.0063	0.0515	0.5204	0.0908

INDICATORS OF WASTE GENERATION - AIR AREA SOURCES
(PM, SO_2, NO_X, VOC, CO)

INDICATORS OF WASTE GENERATION -- AIR

AREA SOURCE EMISSIONS OF PARTICULATES, SO2, NOX, VOC'S AND CO.

SIC 1980 Code	SECTOR NAME	PM (Area Based) Tonne/Year 1986	SO2 (Area Based) Tonne/Year 1986	NOx (Area Based) Tonne/Year 1986	VOC (Area Based) Tonne/Year 1986	CO (Area Based) Tonne/Year 1986
011-023	Agriculture and Related Services	--	--	--	--	--
031-033	Fishing and Trapping	--	--	--	--	--
041-051	Logging and Forestry	--	--	--	--	--
061-092	Mining - Total Extraction	--	--	--	--	--
061-062	Mining (Metals & Non-Metals)	--	--	--	--	--
061	Metal Mining	--	--	--	--	--
0611-0616,0	Metal Mining (Excl. Iron)	--	--	--	--	--
0617	Mining -- Iron	--	--	--	--	--
062-063	Non-Metal Mining & Coal	--	--	--	--	--
062	Non-Metal Mining	--	--	--	--	--
063	Mining -- Coal	--	--	--	--	--
064	Mining - Crude Petroleum & N.G.	--	--	--	--	--
081-082	Mining - Quarry & Sand Pit	--	--	--	--	--
091-092	Mining - Services	--	--	--	--	--
401-449	Construction - Total	--	--	--	--	--
451-479	Transportation & Storage (DIV G)		--	--	--	--
451-459	Transportation - Total	--	--	--	--	--
451-452	Transportation - Air	450.0	696.0	11,942.0	5,437.0	43,073.0
453	Transportation - Railway	1,346.0	1,982.0	24,937.0	1,211.0	9,970.0
454-455	Transportation - Water	661.0	7,442.0	8,364.0	13,445.0	37,499.0
456-459	Transportation - Motor & Misc.	--	--	--	--	--
456	Transportation - Motor - Truck	--	--	--	--	--
457-459	Transportation - Motor - Other	--	--	--	--	--
461	Transportation - Pipeline	--	--	--	--	--
471-479	Storage and Warehousing	--	--	--	--	--
481-499	Communications & Utilities (Div H)	--	--	--	--	--
481-484	Communication - Total	--	--	--	--	--
481	Communication - Radio TV Cable	--	--	--	--	--
482-483	Communication - Carriers & Other	--	--	--	--	--
484	Communication - Postal	--	--	--	--	--
491-499	Utilities - Total	--	--	--	--	--
491	Utilities - Electric Power	--	--	--	--	--
492	Utilities - Gas	--	--	--	--	--
493-499	Utilities - Water & Other	--	--	--	--	--

INDICATORS OF WASTE GENERATION -- AIR

AREA SOURCE EMISSIONS OF PARTICULATES, SO2, NOX, VOC'S AND CO.

SIC 1980 Code	SECTOR NAME	PM (Area Based) Tonne/Year 1986	SO2 (Area Based) Tonne/Year 1986	NOx (Area Based) Tonne/Year 1986	VOC (Area Based) Tonne/Year 1986	CO (Area Based) Tonne/Year 1986
501-692	Trade - Total Wholesale/Retail	--	--	--	--	--
501-559	Trade - Wholesale	--	--	--	--	--
601-692	Trade - Retail	34,563.0	17,742.0	261,915.0	226,971.0	1,769,503.0
701-761	Fin, Insur, Real Est. - Total	--	--	--	--	--
701-749	Finance - Personal	--	--	--	--	--
--	Finance - Royalties + Imputed	--	--	--	--	--
--	Finance - Govt Royalties	--	--	--	--	--
--	Fin - Owner Ocupied Dwellings	--	--	--	--	--
771-999	Community Business & Pers Serv	--	--	--	--	--
771-779	Services - Business	--	--	--	--	--
779	Other Business Services	--	--	--	--	--
775-779	Professional Business Services	--	--	--	--	--
774	Advertising Services	--	--	--	--	--
851-859	Services - Education	--	--	--	--	--
861-869	Services - Health & Social	--	--	--	--	--
861	Services - Health - Hospitals	--	--	--	--	--
862-869	Services- Health - Phys & Oth H	--	--	--	--	--
911-922	Services - Accomm & Food	--	--	--	--	--
961-999	Other Services (Div R)	--	--	--	--	--
961-969	Services - Recreation & Amusement	--	--	--	--	--
971-999	Services - Personal	--	--	--	--	--
811-841	Public Administration - Total	--	--	--	--	--
811-817	Public Admin - Fed & Defence	--	--	--	--	--
811	Public Admin - Defence	--	--	--	--	--
812-817	Federal Government Services	--	--	--	--	--
822-827	Public Administration - Prov	--	--	--	--	--
832-837	Public Administration - Local	--	--	--	--	--

INDICATORS OF WASTE GENERATION -- AIR

AREA SOURCE EMISSIONS OF PARTICULATES, SO2, NOX,
VOC'S AND CO.

SIC 1980 Code	SECTOR NAME	PM (Area Based) Tonne/Year 1986	SO2 (Area Based) Tonne/Year 1986	NOx (Area Based) Tonne/Year 1986	VOC (Area Based) Tonne/Year 1986	CO (Area Based) Tonne/Year 1986
	MANUFACTURING					
--	Manufacturing - Total	--	--	--	--	--
101-109	Food Prod. - Total (Excl. Beverages)	--	--	--	--	--
102	Food Production - Fish	--	--	--	--	--
101,103-109	Food Prod. - Other than Fish	--	--	--	--	--
111-114	Beverages	--	--	--	--	--
121-122	Tobacco	--	--	--	--	--
151-159	Rubber	--	--	--	--	--
161-169	Plastic	--	--	--	--	--
171	Leather	--	--	--	--	--
181-199	Primary Textiles & Textile Products	--	--	--	--	--
243-249	Garments and Clothing	--	--	--	--	--
251-259	Wood	--	--	--	--	--
261-269	Furniture	--	--	--	--	--
271-279	Paper & Allied- Total	--	--	--	--	--
271	Paper & Allied- Pulp & Paper	--	--	--	--	--
272-279	Paper & Allied- Paper Conv	--	--	--	--	--
281-284	Printing & Publishing	--	--	--	--	--
291-299	Primary Metal - Total	--	--	--	--	--
291-294	Primary Metal - Iron and Steel	--	--	--	--	--
295-299	Primary Metal - Non-Ferrous	--	--	--	--	--
301-309	Metal Fabrication - Total	--	--	--	--	--
311-319	Machinery (Excl. Electrical) - Total	--	--	--	--	--
321-329	Transportation Equipment - Total	--	--	--	--	--
323	Transportation Equip. - Motor Vehicle	--	--	--	--	--
321	Transportation Equip. - Aircraft etc.	--	--	--	--	--
326,329	Railroad Rolling Stock & Misc.	--	--	--	--	--
327-328	Transportation Equip. - Shipbuilding	--	--	--	--	--
331-339	Electrical Equipment - Total	--	--	--	--	--
351-359	Non-Metallic Mineral - Total	--	--	--	--	--
351,354-355	Non-Metallic Cement & Clay Production	--	--	--	--	--
356	Non-Metallic - Glass	--	--	--	--	--
361-369	Petroleum & Coal- Total	--	--	--	--	--

INDICATORS OF WASTE GENERATION -- AIR

AREA SOURCE EMISSIONS OF PARTICULATES, SO2, NOX,
VOC'S AND CO.

SIC 1980 Code	SECTOR NAME	PM (Area Based) Tonne/Year 1986	SO2 (Area Based) Tonne/Year 1986	NOx (Area Based) Tonne/Year 1986	VOC (Area Based) Tonne/Year 1986	CO (Area Based) Tonne/Year 1986
371-379	Chemicals - Total	--	--	--	--	--
371	Chemicals - Industrial	--	--	--	--	--
372-379	Chemicals - Non-Industrial	--	--	--	--	--
391-399	Manufacturing - Other Misc.	--	--	--	--	--

AREA SOURCE EMISSIONS OF PARTICULATES, SO2, NOX, VOC'S AND CO.

SIC 1980 Code	SECTOR NAME	PM (Area Based) Tonnes/M$ RDP 1985	SO2 (Area Based) Tonnes/M$ RDP 1985	NOx (Area Based) Tonnes/M$ RDP 1985	VOC (Area Based) Tonnes/M$ RDP 1985	CO (Area Based) Tonnes/M$ RDP 1985
	Business					
011-023	Agriculture and Related Services	--	--	--	--	--
031-033	Fishing and Trapping	--	--	--	--	--
041-051	Logging and Forestry	--	--	--	--	--
061-092	Mining - Total Extraction	--	--	--	--	--
061-062	Mining (Metals & Non-Metals)	--	--	--	--	--
061	Metal Mining	--	--	--	--	--
0611-0616,0	Metal Mining (Excl. Iron)	--	--	--	--	--
0617	Mining -- Iron	--	--	--	--	--
062-063	Non-Metal Mining & Coal	--	--	--	--	--
062	Non-Metal Mining	--	--	--	--	--
063	Mining -- Coal	--	--	--	--	--
064	Mining - Crude Petroleum & N.G.	--	--	--	--	--
081-082	Mining - Quarry & Sand Pit	--	--	--	--	--
091-092	Mining - Services	--	--	--	--	--
401-449	Construction - Total	--	--	--	--	--
451-479	Transportation & Storage (DIV G)	--	--	--	--	--
451-459	Transportation - Total	--	--	--	--	--
451-452	Transportation - Air	0.4802	0.7426	12.7422	5.8013	49.9065
453	Transportation - Railway	1.8133	2.8118	35.3771	1.7180	14.1440
454-455	Transportation - Water	1.6051	18.0719	20.3108	32.6493	123.4772
456-459	Transportation - Motor & Misc.	--	--	--	--	--
456	Transportation - Motor - Truck	--	--	--	--	--
457-459	Transportation - Motor - Other	--	--	--	--	--
461	Transportation - Pipeline	--	--	--	--	--
471-479	Storage and Warehousing	--	--	--	--	--
481-499	Communications & Utilities (Div H)	--	--	--	--	--
481-484	Communication - Total	--	--	--	--	--
481	Communication - Radio TV Cable	--	--	--	--	--
482-483	Communication - Carriers & Other	--	--	--	--	--
484	Communication - Postal	--	--	--	--	--

INDICATORS OF WASTE GENERATION -- AIR

Environment - Economy Linkages

AREA SOURCE EMISSIONS OF PARTICULATES, SO2, NOX,
VOC'S AND CO.

SIC 1980 Code	SECTOR NAME	PM (Area Based) Tonnes/M$ RDP 1985	SO2 (Area Based) Tonnes/M$ RDP 1985	NOx (Area Based) Tonnes/M$ RDP 1985	VOC (Area Based) Tonnes/M$ RDP 1985	CO (Area Based) Tonnes/M$ RDP 1985
491-499	Utilities - Total	--	--	--	--	--
491	Utilities - Electric Power	--	--	--	--	--
492	Utilities - Gas	--	--	--	--	--
493-499	Utilities - Water & Other	--	--	--	--	--
501-692	Trade - Total Wholesale/Retail	--	--	--	--	--
501-559	Trade - Wholesale	--	--	--	--	--
601-692	Trade - Retail	3.9477	2.0264	29.9150	25.9238	212.3182
701-761	Fin, Insur, Real Est. - Total	--	--	--	--	--
701-749	Finance - Personal	--	--	--	--	--
--	Finance - Royalties + Imputed	--	--	--	--	--
--	Finance - Govt Royalties	--	--	--	--	--
--	Fin - Owner Ocupied Dwellings	--	--	--	--	--
771-999	Community Business & Pers Serv	--	--	--	--	--
771-779	Services - Business	--	--	--	--	--
779	Other Business Services	--	--	--	--	--
775-779	Professional Business Services	--	--	--	--	--
774	Advertising Services	--	--	--	--	--
851-859	Services - Education	--	--	--	--	--
861-869	Services - Health & Social	--	--	--	--	--
861	Services - Health - Hospitals	--	--	--	--	--
862-869	Services- Health - Phys & Oth H	--	--	--	--	--
911-922	Services - Accomm & Food	--	--	--	--	--
961-999	Other Services (Div R)	--	--	--	--	--
961-969	Services - Recreation & Amusement	--	--	--	--	--
971-999	Services - Personal	--	--	--	--	--
811-841	Public Administration - Total	--	--	--	--	--
811-817	Public Admin - Fed & Defence	--	--	--	--	--
811	Public Admin - Defence	--	--	--	--	--
812-817	Federal Government Services	--	--	--	--	--
822-827	Public Administration - Prov	--	--	--	--	--
832-837	Public Administration - Local	--	--	--	--	--

INDICATORS OF WASTE GENERATION -- AIR

Environment - Economy Linkages

AREA SOURCE EMISSIONS OF PARTICULATES, SO2, NOX, VOC'S AND CO.

SIC 1980 Code	SECTOR NAME	PM (Area Based) Tonnes/M$ RDP 1985	SO2 (Area Based) Tonnes/M$ RDP 1985	NOx (Area Based) Tonnes/M$ RDP 1985	VOC (Area Based) Tonnes/M$ RDP 1985	CO (Area Based) Tonnes/M$ RDP 1985
	MANUFACTURING					
--	Manufacturing - Total	--	--	--	--	--
101-109	Food Prod. - Total (Excl. Beverages)	--	--	--	--	--
102	Food Production - Fish	--	--	--	--	--
101,103-109	Food Prod. - Other than Fish	--	--	--	--	--
111-114	Beverages	--	--	--	--	--
121-122	Tobacco	--	--	--	--	--
151-159	Rubber	--	--	--	--	--
161-169	Plastic	--	--	--	--	--
171	Leather	--	--	--	--	--
181-199	Primary Textiles & Textile Products	--	--	--	--	--
243-249	Garments and Clothing	--	--	--	--	--
251-259	Wood	--	--	--	--	--
261-269	Furniture	--	--	--	--	--
271-279	Paper & Allied- Total	--	--	--	--	--
271	Paper & Allied- Pulp & Paper	--	--	--	--	--
272-279	Paper & Allied- Paper Conv	--	--	--	--	--
281-284	Printing & Publishing	--	--	--	--	--
291-299	Primary Metal - Total	--	--	--	--	--
291-294	Primary Metal - Iron and Steel	--	--	--	--	--
295-299	Primary Metal - Non-Ferrous	--	--	--	--	--
301-309	Metal Fabrication - Total	--	--	--	--	--
311-319	Machinery (Excl. Electrical) - Total	--	--	--	--	--
321-329	Transportation Equipment - Total	--	--	--	--	--
323	Transportation Equip. - Motor Vehicle	--	--	--	--	--
321	Transportation Equip. - Aircraft etc.	--	--	--	--	--
326,329	Railroad Rolling Stock & Misc.	--	--	--	--	--
327-328	Transportation Equip. - Shipbuilding	--	--	--	--	--
331-339	Electrical Equipment - Total	--	--	--	--	--
351-359	Non-Metallic Mineral - Total	--	--	--	--	--
351,354-355	Non-Metallic Cement & Clay Production	--	--	--	--	--

INDICATORS OF WASTE GENERATION -- AIR

Environment - Economy Linkages

AREA SOURCE EMISSIONS OF PARTICULATES, SO2, NOX,
VOC'S AND CO.

SIC 1980 Code	SECTOR NAME	PM (Area Based) Tonnes/M$ RDP 1985	SO2 (Area Based) Tonnes/M$ RDP 1985	NOx (Area Based) Tonnes/M$ RDP 1985	VOC (Area Based) Tonnes/M$ RDP 1985	CO (Area Based) Tonnes/M$ RDP 1985
356	Non-Metallic - Glass	--	--	--	--	--
361-369	Petroleum & Coal- Total	--	--	--	--	--
371-379	Chemicals - Total	--	--	--	--	--
371	Chemicals - Industrial	--	--	--	--	--
372-379	Chemicals - Non-Industrial	--	--	--	--	--
391-399	Manufacturing - Other Misc.	--	--	--	--	--

INDICATORS OF WASTE GENERATION - AIR
(CO_2, N_2O, CH4)

GREEN HOUSE GAS EMISSIONS: CO2, CH4, N20 FOR 1988

SIC 1980 Code	SECTOR NAME	CO2 Tonne/Year	N20 Tonne/Year	CH4 Tonne/Year
501-692	Trade - Total Wholesale/Retail	--	--	--
501-559	Trade - Wholesale	--	--	--
601-692	Trade - Retail	39,981,857	4,540	--
701-761	Fin, Insur, Real Est. - Total	--	--	--
701-749	Finance - Personal	--	--	--
--	Finance - Royalties + Imputed	--	--	--
--	Finance - Govt Royalties	--	--	--
--	Fin - Owner Ocupied Dwellings	--	--	--
771-999	Community Business & Pers Serv	9,231,709	--	--
771-779	Services - Business	--	--	--
779	Other Business Services	--	--	--
775-779	Professional Business Services	--	--	--
774	Advertising Services	--	--	--
851-859	Services - Education	--	--	--
861-869	Services - Health & Social	--	--	--
861	Services - Health - Hospitals	--	--	--
862-869	Services- Health - Phys & Oth H	--	--	--
911-922	Services - Accomm & Food	--	--	--
961-999	Other Services (Div R)	--	--	--
961-969	Services - Recreation & Amusement	--	--	--
971-999	Services - Personal	--	--	--
811-841	Public Administration - Total	--	--	--
811-817	Public Admin - Fed & Defence	--	--	--
811	Public Admin - Defence	--	--	--
812-817	Federal Government Services	--	--	--
822-827	Public Administration - Prov	--	--	--
832-837	Public Administration - Local	--	--	--

GREEN HOUSE GAS EMISSIONS: CO2, CH4, N2O FOR 1988

SIC 1980 Code	SECTOR NAME	CO2 Tonne/Year	N2O Tonne/Year	CH4 Tonne/Year
--	Manufacturing - Total	--	--	--
101-109	Food Prod. - Total (Excl. Beverages)	--	--	--
102	Food Production - Fish	--	--	--
101,103-109	Food Prod. - Other than Fish	--	--	--
111-114	Beverages	--	--	--
121-122	Tobacco	--	--	--
151-159	Rubber	--	--	--
161-169	Plastic	--	--	--
171	Leather	--	--	--
181-199	Primary Textiles & Textile Products	--	--	--
243-249	Garments and Clothing	--	--	--
251-259	Wood	--	--	--
261-269	Furniture	--	--	--
271-279	Paper & Allied- Total	--	--	--
271	Paper & Allied- Pulp & Paper	8,698,000	857	15
272-279	Paper & Allied- Paper Conv	--	--	--
281-284	Printing & Publishing	--	--	--
291-299	Primary Metal - Total	--	--	--
291-294	Primary Metal - Iron and Steel	1,129,000	56	33
295-299	Primary Metal - Non-Ferrous	--	--	--
301-309	Metal Fabrication - Total	--	--	--
311-319	Machinery (Excl. Electrical) - Total	--	--	--
321-329	Transportation Equipment - Total	--	--	--
323	Transportation Equip. - Motor Vehicle	--	--	--
321	Transportation Equip. - Aircraft etc.	--	--	--
326,329	Railroad Rolling Stock & Misc.	--	--	--
327-328	Transportation Equip. - Shipbuilding	--	--	--
331-339	Electrical Equipment - Total	--	--	--
351-359	Non-Metallic Mineral - Total	22,791,000	832	5
351,354-355	Non-Metallic Cement & Clay Production	--	--	--
356	Non-Metallic - Glass	--	--	--

GREEN HOUSE GAS EMISSIONS: CO2, CH4, N2O FOR 1988

SIC 1980 Code	SECTOR NAME	CO2 Tonne/Year	N2O Tonne/Year	CH4 Tonne/Year
361-369	Petroleum & Coal- Total	--	--	--
371-379	Chemicals - Total	2,602,000	--	29
371	Chemicals - Industrial	1,596,000	21,240	--
372-379	Chemicals - Non-Industrial	--	--	--
391-399	Manufacturing - Other Misc.	--	--	--
	HOUSEHOLD SECTOR	18,797,000	22,140	1,474
	COMMERCIAL SECTOR	9,233,000	520	273

Environment - Economy Linkages

GREEN HOUSE GAS EMISSIONS: CO_2, CH_4, N_2O FOR 1988

SIC 1980 Code	SECTOR NAME	CO_2 Tonne/Million $ ROP	N_2O Tonne/Million $ ROP	CH_4 Tonne/Million $ ROP
	Business			
011-023	Agriculture and Related Services	643.3697	0.6463	166.3820
031-033	Fishing and Trapping	--	--	--
041-051	Logging and Forestry	--	--	--
061-092	Mining - Total Extraction	252.1311	0.0199	0.0058
061-062	Mining (Metals & Non-Metals)	--	--	--
061	Metal Mining	--	--	--
0611-0616,0	Metal Mining (Excl. Iron)	--	--	--
0617	Mining -- Iron	--	--	--
062-063	Non-Metal Mining & Coal	--	--	--
062	Non-Metal Mining	--	--	--
063	Mining -- Coal	--	--	--
064	Mining - Crude Petroleum & N.G.	--	--	--
081-082	Mining - Quarry & Sand Pit	--	--	--
091-092	Mining - Services	--	--	--
401-449	Construction - Total	63.8908	0.0086	0.0016
451-479	Transportation & Storage (DIV G)	--	--	--
451-459	Transportation - Total	--	--	--
451-452	Transportation - Air	3,946.4614	0.3386	--
453	Transportation - Railway	--	--	--
454-455	Transportation - Water	--	--	--
456-459	Transportation - Motor & Misc.	--	0.0087	--
456	Transportation - Motor - Truck	324.8806	--	--
457-459	Transportation - Motor - Other	--	--	--
461	Transportation - Pipeline	6,986.2817	--	--
471-479	Storage and Warehousing	--	--	--
481-499	Communications & Utilities (Div H)	--	--	--
481-484	Communication - Total	--	--	--
481	Communication - Radio TV Cable	--	--	--
482-483	Communication - Carriers & Other	--	--	--
484	Communication - Postal	--	--	--
491-499	Utilities - Total	--	--	--
491	Utilities - Electric Power	10,647.6392	1.3183	--
492	Utilities - Gas	--	--	--
493-499	Utilities - Water & Other	6,179.8795	--	1,637.8535

Environment - Economy Linkages

GREEN HOUSE GAS EMISSIONS: CO2, CH4, N2O FOR 1988

SIC 1980 Code	SECTOR NAME	CO2 Tonne/Million $ RDP	N2O Tonne/Million $ RDP	CH4 Tonne/Million $ RDP
501-692	Trade - Total Wholesale/Retail	--	--	--
501-559	Trade - Wholesale	--	--	--
601-692	Trade - Retail	4,128.9217	0.4688	--
701-761	Fin, Insur, Real Est. - Total	--	--	--
701-749	Finance - Personal	--	--	--
--	Finance - Royalties + Imputed	--	--	--
--	Finance - Govt Royalties	--	--	--
--	Fin - Owner Occupied Dwellings	--	--	--
771-999	Community Business & Pers Serv	297.1000	--	--
771-779	Services - Business	--	--	--
779	Other Business Services	--	--	--
775-779	Professional Business Services	--	--	--
774	Advertising Services	--	--	--
851-859	Services - Education	--	--	--
861-869	Services - Health & Social	--	--	--
861	Services - Health - Hospitals	--	--	--
862-869	Services- Health - Phys & Oth H	--	--	--
911-922	Services - Accomm & Food	--	--	--
961-999	Other Services (Div R)	--	--	--
961-969	Services - Recreation & Amusement	--	--	--
971-999	Services - Personal	--	--	--
811-841	Public Administration - Total	--	--	--
811-817	Public Admin - Fed & Defence	--	--	--
811	Public Admin - Defence	--	--	--
812-817	Federal Government Services	--	--	--
822-827	Public Administration - Prov	--	--	--
832-837	Public Administration - Local	--	--	--

Environment - Economy Linkages

GREEN HOUSE GAS EMISSIONS: CO2, CH4, N2O FOR 1988

SIC 1980 Code	SECTOR NAME	CO2 Tonne/Million $ ROP	N2O Tonne/Million $ ROP	CH4 Tonne/Million $ ROP
--	Manufacturing - Total	--	--	--
101-109	Food Prod. - Total (Excl. Beverages)	--	--	--
102	Food Production - Fish	--	--	--
101,103-109	Food Prod. - Other than Fish	--	--	--
111-114	Beverages	--	--	--
121-122	Tobacco	--	--	--
151-159	Rubber	--	--	--
161-169	Plastic	--	--	--
171	Leather	--	--	--
181-199	Primary Textiles & Textile Products	--	--	--
243-249	Garments and Clothing	--	--	--
251-259	Wood	--	--	--
261-269	Furniture	--	--	--
271-279	Paper & Allied- Total	--	--	--
271	Paper & Allied- Pulp & Paper	6,658.0989	0.6560	0.0115
272-279	Paper & Allied- Paper Conv	--	--	--
281-284	Printing & Publishing	--	--	--
291-299	Primary Metal - Total	--	--	--
291-294	Primary Metal - Iron and Steel	502.1327	0.0249	0.0147
295-299	Primary Metal - Non-Ferrous	--	--	--
301-309	Metal Fabrication - Total	--	--	--
311-319	Machinery (Excl. Electrical) - Total	--	--	--
321-329	Transportation Equipment - Total	--	--	--
323	Transportation Equip. - Motor Vehicle	--	--	--
321	Transportation Equip. - Aircraft etc.	--	--	--
326,329	Railroad Rolling Stock & Misc.	--	--	--
327-328	Transportation Equip. - Shipbuilding	--	--	--
331-339	Electrical Equipment - Total	--	--	--
351-359	Non-Metallic Mineral - Total	16,871.2795	0.6159	0.0037
351,354-355	Non-Metallic Cement & Clay Production	--	--	--
356	Non-Metallic - Glass	--	--	--

Environment - Economy Linkages

GREEN HOUSE GAS EMISSIONS: CO2, CH4, N2O FOR 1988

SIC 1980 Code	SECTOR NAME	CO_2 Tonne/Million $ RDP	N_2O Tonne/Million $ RDP	CH_4 Tonne/Million $ RDP
361-369	Petroleum & Coal- Total	--	--	--
371-379	Chemicals - Total	870.1395	--	0.0097
371	Chemicals - Industrial	1,703.1987	22.6666	--
372-379	Chemicals - Non-Industrial	--	--	--
391-399	Manufacturing - Other Misc.	--	--	--

INDICATORS OF WASTE GENERATION - WATER INDUSTRIAL WATER DISCHARGES

INDICATORS OF WASTE GENERATION -- WATER DISCHARGES

INDUSTRIAL WATER DISCHARGES	FLOW (m3/day)	TOTAL FINAL LOADINGS			TOTAL FINAL LOADINGS			
		CONVENTIONALS (kg/yr)	NON-CONVENTIONALS (kg/yr)	TOXICS (kg/yr)	TOC	TKN	BOD	COD
SIC# 291 -- IRON & STEEL SECTOR:	--	8,724,047.2	1,196,278.9	46,070.8	--	--	--	--
SIC# 371 -- INDUSTRIAL CHEMICALS:	442,327	10,211,238.8	347,180,161.9	215,250.0	--	564,250.0	--	--
SIC# 0612-0614 -- CU/PB/ZI/NI MINING:	275,251	2,104,508.0	--	151,538.0	--	--	--	--
SIC# 0611 -- GOLD:	287,968	1,903,371.0	--	135,650.0	--	--	--	--
SIC# 0617 -- IRON:	9,621	38,157.0	--	2,174.0	--	--	--	--
SIC# 0616 -- URANIUM:	113,788	2,914,825.0	--	32,241.0	--	--	--	--
SIC# 061 -- METAL MINING:	686,628	6,960,861.0	--	321,603.0	--	--	--	--
SIC# 271 -- PULP AND PAPER	28,301	294,670,864.5	--	4,219,400.0	--	745,333.0	64,222,480.0	129,669,900.0
SIC# 3611 -- PETROLEUM REFINING:	65,765	1,612,985.3	--	4,147.9	96,301.6	--	--	797,648.0
SIC# 493-499 UTILITIES - WATER & OTHER:	4,291,660	60,972,272.2	--	907,478.2	--	--	28,079,873.0	--
TOTAL	5,514,681	383,152,268.9	348,376,440.8	5,713,949.9	96,301.6	1,309,583.0	92,302,353.0	130,467,548.0

INDICATORS OF WASTE GENERATION -- WATER DISCHARGES

Environment - Economy Linkages

INDUSTRIAL WATER DISCHARGES	FLOW m3/day per Million $ RDP	TOTAL FINAL LOADINGS			TOTAL FINAL LOADINGS			
		CONVENTIONALS kg/Million RDP	NON-CONVENTIONALS kg/Million RDP	TOXICS kg/Million RDP	TOC Per Million RDP	TKN Per Million RDP	BOD Per Million RDP	COD Per Million RDP
SIC# 291 -- IRON & STEEL SECTOR:	--	4,430.7	607.6	23.4	--	--	--	--
SIC# 371 -- INDUSTRIAL CHEMICALS:	153.7	11,487.5	390,572.8	242.2	--	196.0	--	--
SIC# 0612-0614 -- CU/PB/ZI/NI MINING:	--	--	--	--	--	--	--	--
SIC# 0611 -- GOLD:	--	--	--	--	--	--	--	--
SIC# 0617 -- IRON:	--	--	--	--	--	--	--	--
SIC# 0616 -- URANIUM:	--	--	--	--	--	--	--	--
SIC# 061 -- METAL MINING:	345.4	3,501.1	--	161.8	--	--	--	--
SIC# 271 -- PULP AND PAPER	1,356.8	216,956.9	--	3,106.6	--	549.4	47,335.5	95,573.9
SIC# 3611 -- PETROLEUM REFINING:	169.5	4,370.0	--	11.2	248.3	--	--	2,056.3
SIC# 493-499 UTILITIES - WATER & OTHER:	--	123,701.1	--	1,841.1	--	--	56,968.7	--
TOTAL	2,025.4	54,222.5	49,301.1	808.6	10.6	144.3	10,173.5	14,380.1

INDICATORS OF WASTE GENERATION - LAND
INDUSTRIAL SOLID WASTE

INDUSTRIAL SOLID WASTE FOR 1989

SIC 1980 Code	SECTOR NAME	OCC Tonne/Year	OFFICE PAPER Tonne/Year	OTHER PAPER Tonne/Year	WOOD Tonne/Year	GLASS Tonne/Year	PLASTIC Tonne/Year	ORGANICS Tonne/Year	METALS Tonne/Year	TIRES Tonne/Year	OTHER Tonne/Year	TOTAL Tonne/Year
501-599,601-692	Trade - Total Wholesale/Retail	--	--	--	--	--	--	--	--	--	--	--
501-559	Trade - Wholesale	172,770	--	4,949	36,295	--	15,123	--	--	--	--	229,137
601-692	Trade - Retail	270,918	15,262	7,493	43,968	937	33,059	110,417	24,133	18,348	26,447	550,982
701-761	Fin, Insur, Real Est. - Total	--	--	--	--	--	--	--	--	--	--	--
701-749	Finance - Personal	--	--	--	--	--	--	--	--	--	--	--
--	Finance - Royalties + Imputed	--	--	--	--	--	--	--	--	--	--	--
--	Finance - Govt Royalties	--	--	--	--	--	--	--	--	--	--	--
--	Fin - Owner Ocupied Dwellings	--	--	--	--	--	--	--	--	--	--	--
771-999	Community Business & Pers Serv	333,763	162,422	262,090	124,156	239,941	56,738	42,223	136,282	18,747	131,457	2,587,153
771-779	Services - Business	--	--	--	--	--	--	--	--	--	--	--
779	Other Business Services	--	--	--	--	--	--	--	--	--	--	--
851-869	Professional Business Services	--	--	--	--	--	--	--	--	--	--	--
774	Advertising Services	--	--	--	--	--	--	--	--	--	--	--
851-859	Services - Education	--	--	--	--	--	--	--	--	--	--	--
861-869	Services - Health & Social	--	--	--	--	--	--	--	--	--	--	--
861	Services - Health - Hospitals	--	--	--	--	--	--	--	--	--	--	--
862-869	Services- Health - Phys & Oth H	--	--	--	--	--	--	--	--	--	--	--
911-922	Services - Accomm & Food	--	--	--	--	--	--	--	--	--	--	--
961-999	Other Services (Div R)	--	--	--	--	--	--	--	--	--	--	--
961-969	Services - Recreation & Amusement	--	--	--	--	--	--	--	--	--	--	--
971-999	Services - Personal	--	--	--	--	--	--	--	--	--	--	--
811-841	Public Administration - Total	--	--	--	--	--	--	--	--	--	--	--
811-817	Public Admin - Fed & Defence	--	--	--	--	--	--	--	--	--	--	--
811	Public Admin - Defence	--	--	--	--	--	--	--	--	--	--	--
812-817	Federal Government Services	--	--	--	--	--	--	--	--	--	--	--
822-827	Public Administration - Prov	--	--	--	--	--	--	--	--	--	--	--
832-837	Public Administration - Local	--	--	--	--	--	--	--	--	--	--	--

SIC 1980 Code	SECTOR NAME	OCC	OFFICE PAPER	OTHER PAPER	WOOD	GLASS	PLASTIC	ORGANICS	METALS	TIRES	OTHER	TOTAL
		Tonne/Year	Tonne/Year	Tonne/Year	Tonne/Year	Tonne/Year	Tonne/Year	Tonne/Year	Tonne/Year	Tonne/Year	Tonne/Year	Tonne/Year
	MANUFACTURING											
--	Manufacturing - Total	--	--	--	--	--	--	--	--	--	--	--
101-114	Food Production Including Beverages	58,982	3,470	15,939	8,725	36,860	8,416	134,110	21,951	--	55,101	343,554
102	Food Production - Fish	--	--	--	--	--	--	--	--	--	--	--
101,103-109	Food Prod. - Other than Fish	--	--	--	--	--	--	--	--	--	--	--
111-114	Beverages	--	--	--	--	--	--	--	--	--	--	--
121-122	Tobacco	--	--	--	--	--	--	--	--	--	--	--
151-159	Rubber	--	--	--	--	--	--	--	--	--	--	--
161-169	Plastic	--	--	--	--	--	--	--	--	--	--	--
171	Leather	--	--	--	--	--	--	--	--	--	--	--
151-171	Rubber/Plastic/Leather	37,820	837	1,725	66,132	--	23,969	--	7,350	15,692	18,254	368,494
181-249	Textiles, Textile Products, Clothing	1,031	139	6,163	589	--	3,006	--	435	--	23,473	34,836
243-249	Garments and Clothing	--	--	--	--	--	--	--	--	--	--	--
251-259	Wood	2,634	--	8	16,119	26	1,389	--	368	--	5,723	26,267
261-269	Furniture	17,138	682	--	12,638	--	--	--	4,993	--	59,295	94,746
271-279	Paper & Allied- Total	17,050	11,126	--	32,880	--	163	5,825	17,537	--	5,725	90,306
271	Paper & Allied- Pulp & Paper	--	--	--	--	--	--	--	--	--	--	--
272-279	Paper & Allied- Paper Conv	--	--	--	--	--	--	--	--	--	--	--
281-284	Printing & Publishing	2,258	2,112	33,722	1,125	--	68	--	77	--	3,391	42,753
291-298	Primary Metal - Total	17,003	55	16,981	50,944	--	--	--	1,576	--	22,868	109,427
291-294	Primary Metal - Iron and Steel	--	--	--	--	--	--	--	--	--	--	--
295-298	Primary Metal - Non-Ferrous	--	--	--	--	--	--	--	--	--	--	--
301-309	Metal Fabrication - Total	23,426	143	18,669	18,991	36	1,735	36	79,130	--	36,659	178,825
311-319	Machinery (Excl. Electrical) - Total	8,054	84	620	5,452	--	1,693	662	11,392	--	24,625	52,582
321-329	Transportation Equipment - Total	50,023	1,622	4,904	41,309	1,509	151	302	100,651	--	176,780	377,251
323	Transportation Equip. - Motor Vehicle	--	--	--	--	--	--	--	--	--	--	--
321	Transportation Equip. - Aircraft etc.	--	--	--	--	--	--	--	--	--	--	--
326,329	Railroad Rolling Stock & Misc.	--	--	--	--	--	--	--	--	--	--	--
327-328	Transportation Equip. - Shipbuilding	--	--	--	--	--	--	--	--	--	--	--
331-339	Electrical Equipment - Total	30,945	2,114	26,941	31,517	--	3,360	--	6,066	--	1,185	102,128
351-359	Non-Metallic Mineral - Total	2,891	2,187	--	1,903	--	11	--	35,889	--	13,915	56,796
351,354-355	Non-Metallic Cement & Clay Production	--	--	--	--	--	--	--	--	--	--	--
356	Non-Metallic - Glass	--	--	--	--	--	--	--	--	--	--	--

INDUSTRIAL SOLID WASTE FOR 1989

SIC 1980 Code	SECTOR NAME	OCC Tonne/M$RDP	OFFICE PAPER Tonne/M$RDP	OTHER PAPER Tonne/M$RDP	WOOD Tonne/M$RDP	GLASS Tonne/M$RDP
501-599,601-692	Trade - Total Wholesale/Retail	--	--	--	--	--
501-559	Trade - Wholesale	16.5479	--	0.4740	3.4763	--
601-692	Trade - Retail	27.6444	1.5573	0.7646	4.4865	0.0956
701-761	Fin, Insur, Real Est. - Total	--	--	--	--	--
701-749	Finance - Personal	--	--	--	--	--
--	Finance - Royalties + Imputed	--	--	--	--	--
--	Finance - Govt Royalties	--	--	--	--	--
--	Fin - Owner Ocupied Dwellings	--	--	--	--	--
771-999	Community Business & Pers Serv	10.3379	5.0308	8.1179	3.8456	7.4319
771-779	Services - Business	--	--	--	--	--
779	Other Business Services	--	--	--	--	--
851-869	Professional Business Services	--	--	--	--	--
774	Advertising Services	--	--	--	--	--
851-859	Services - Education	--	--	--	--	--
861-869	Services - Health & Social	--	--	--	--	--
861	Services - Health - Hospitals	--	--	--	--	--
862-869	Services- Health - Phys & Oth H	--	--	--	--	--
911-922	Services - Accomm & Food	--	--	--	--	--
961-999	Other Services (Div R)	--	--	--	--	--
961-969	Services - Recreation & Amusement	--	--	--	--	--
971-999	Services - Personal	--	--	--	--	--
811-841	Public Administration - Total	--	--	--	--	--
811-817	Public Admin - Fed & Defence	--	--	--	--	--
811	Public Admin - Defence	--	--	--	--	--
812-817	Federal Government Services	--	--	--	--	--
822-827	Public Administration - Prov	--	--	--	--	--
832-837	Public Administration - Local	--	--	--	--	--

Economy - Environment Linkages

INDUSTRIAL SOLID WASTE FOR 1989

SIC 1980 Code	SECTOR NAME	OCC Tonne/M$RDP	OFFICE PAPER Tonne/M$RDP	OTHER PAPER Tonne/M$RDP	WOOD Tonne/M$RDP	GLASS Tonne/M$RDP
	MANUFACTURING					
--	Manufacturing - Total	--	--	--	--	--
101-114	Food Production Including Beverages	18.3764	1.0811	4.9660	2.7184	11.4841
102	Food Production - Fish	--	--	--	--	--
101,103 109	Food Prod. - Other than Fish	--	--	--	--	--
111-114	Beverages	--	--	--	--	--
121-122	Tobacco	--	--	--	--	--
151-159	Rubber	--	--	--	--	--
161-169	Plastic	--	--	--	--	--
171	Leather	--	--	--	--	--
151-171	Rubber/Plastic/Leather	21.6048	0.4781	0.9854	37.7783	--
181-249	Textiles, Textile Products, Clothing	1.1083	0.1494	6.6250	0.6332	--
243-249	Garments and Clothing	--	--	--	--	--
251-259	Wood	3.9079	--	0.0119	23.9145	0.0386
261-269	Furniture	23.0736	0.9182	--	17.0150	--
271-279	Paper & Allied- Total	8.4930	5.5421	--	16.3784	--
271	Paper & Allied- Pulp & Paper	--	--	--	--	--
272-279	Paper & Allied- Paper Conv	--	--	--	--	--
281-284	Printing & Publishing	1.0585	0.9901	15.8086	0.5274	--
291-298	Primary Metal - Total	5.5888	0.0181	5.5816	16.7450	--
291-294	Primary Metal - Iron and Steel	--	--	--	--	--
295-298	Primary Metal - Non-Ferrous	--	--	--	--	--
301-309	Metal Fabrication - Total	7.1021	0.0434	5.6599	5.7575	0.0109
311-319	Machinery (Excl. Electrical) - Total	4.4338	0.0462	0.3413	3.0014	--
321-329	Transportation Equipment - Total	6.2758	0.2035	0.6153	5.1826	0.1893
323	Transportation Equip. - Motor Vehicle	--	--	--	--	--
321	Transportation Equip. - Aircraft etc.	--	--	--	--	--
326,329	Railroad Rolling Stock & Misc.	--	--	--	--	--
327-328	Transportation Equip. - Shipbuilding	--	--	--	--	--
331-339	Electrical Equipment - Total	4.9335	0.3370	4.2952	5.0247	--
351-359	Non-Metallic Mineral - Total	2.1505	1.6268	--	1.4155	--
351,354-355	Non-Metallic Cement & Clay Production	--	--	--	--	--
356	Non-Metallic - Glass	--	--	--	--	--

Economy - Environment Linkages

INDUSTRIAL SOLID WASTE FOR 1989

SIC 1980 Code	SECTOR NAME	OCC Tonne/M$RDP	OFFICE PAPER Tonne/M$RDP	OTHER PAPER Tonne/M$RDP	WOOD Tonne/M$RDP	GLASS Tonne/M$RDP
361-369	Petroleum & Coal- Total	--	--	--	--	--
371-379	Chemicals - Total	31.4725	0.3493	2.4364	0.6430	0.6430
371	Chemicals - Industrial	--	--	--	--	--
372-379	Chemicals - Non-Industrial	--	--	--	--	--
391-399	Manufacturing - Other Misc.	15.4934	0.1951	8.4621	0.3300	0.3300

Economy - Environment Linkages

INDUSTRIAL SOLID WASTE FOR 1989

SIC 1980 Code	SECTOR NAME	PLASTIC Tonne/M$RDP	ORGANICS Tonne/M$RDP	METALS Tonne/M$RDP	TIRES Tonne/M$RDP	OTHER Tonne/M$RDP	TOTAL Tonne/M$RDP
	Business						
011-023	Agriculture and Related Services	--	--	--	--	2.6940	50.0748
031-109	Fishing and Trapping	--	--	--	--	--	--
041-051	Logging and Forestry	--	--	--	--	--	--
061-092	Mining - Total Extraction	--	--	--	--	--	--
061-061	Mining (Metals & Non-Metals)	--	--	--	--	--	--
061	Metal Mining	--	--	--	--	--	--
0611-0616,0619	Metal Mining (Excl. Iron)	--	--	--	--	--	--
0617	Mining -- Iron	--	--	--	--	--	--
062-063	Non-Metal Mining & Coal	--	--	--	--	--	--
062	Non-Metal Mining	--	--	--	--	--	--
063	Mining -- Coal	--	--	--	--	--	--
064	Mining - Crude Petroleum & N.G.	--	--	--	--	--	--
081-082	Mining - Quarry & Sand Pit	--	--	--	--	--	--
091-092	Mining - Services	--	--	--	--	--	--
401-449	Construction - Total	0.6846	1.2012	11.3148	--	51.5234	129.1638
451-479	Transportation & Storage (DIV G)	--	--	--	--	--	--
451-459	Transportation - Total	--	--	--	--	--	29.7156
451-452	Transportation - Air	--	--	--	--	--	--
453	Transportation - Railway	--	--	--	--	--	--
454-455	Transportation - Water	--	--	--	--	--	--
456-459	Transportation - Motor & Misc.	--	--	--	--	--	--
456	Transportation - Motor - Truck	--	--	--	--	--	--
457-459	Transportation - Motor - Other	--	--	--	--	--	--
461	Transportation - Pipeline	--	--	--	--	--	--
471-479	Storage and Warehousing	--	--	--	--	--	--
481-499	Communications & Utilities (Div H)	--	--	--	--	--	--
481-484	Communication - Total	--	--	--	--	--	--
481	Communication - Radio TV Cable	--	--	--	--	--	--
482-483	Communication - Carriers & Other	--	--	--	--	--	--
484	Communication - Postal	--	--	--	--	--	--
491-499	Utilities - Total	--	--	--	--	--	--
491-492	Utilities - Electric Power & Gas	--	--	0.5591	--	3.7679	12.1036
492	Utilities - Gas	--	--	--	--	--	--
493-499	Utilities - Water & Other	--	--	--	--	--	--

Economy - Environment Linkages

INDUSTRIAL SOLID WASTE FOR 1989

SIC 1980 Code	SECTOR NAME	PLASTIC Tonne/M$RDP	ORGANICS Tonne/M$RDP	METALS Tonne/M$RDP	TIRES Tonne/M$RDP	OTHER Tonne/M$RDP	TOTAL Tonne/M$RDP
501-599,601-692	Trade - Total Wholesale/Retail	--	--	--	--	--	--
501-559	Trade - Wholesale	1.4485	--	--	--	--	21.9467
601-692	Trade - Retail	3.3733	11.2669	2.4625	1.8722	2.6986	56.2220
701-761	Fin, Insur, Real Est. - Total	--	--	--	--	--	--
701-749	Finance - Personal	--	--	--	--	--	--
--	Finance - Royalties + Imputed	--	--	--	--	--	--
--	Finance - Govt Royalties	--	--	--	--	--	--
--	Fin - Owner Ocupied Dwellings	--	--	--	--	--	--
771-999	Community Business & Pers Serv	1.7574	1.3078	4.2212	0.5807	4.0717	80.1342
771-779	Services - Business	--	--	--	--	--	--
779	Other Business Services	--	--	--	--	--	--
851-869	Professional Business Services	--	--	--	--	--	--
774	Advertising Services	--	--	--	--	--	--
851-859	Services - Education	--	--	--	--	--	--
861-869	Services - Health & Social	--	--	--	--	--	--
861	Services - Health - Hospitals	--	--	--	--	--	--
862-869	Services- Health - Phys & Oth H	--	--	--	--	--	--
911-922	Services - Accomm & Food	--	--	--	--	--	--
961-999	Other Services (Div R)	--	--	--	--	--	--
961-969	Services - Recreation & Amusement	--	--	--	--	--	--
971-999	Services - Personal	--	--	--	--	--	--
811-841	Public Administration - Total	--	--	--	--	--	--
811-817	Public Admin - Fed & Defence	--	--	--	--	--	--
811	Public Admin - Defence	--	--	--	--	--	--
812-817	Federal Government Services	--	--	--	--	--	--
822-827	Public Administration - Prov	--	--	--	--	--	--
832-837	Public Administration - Local	--	--	--	--	--	--

Economy - Environment Linkages

INDUSTRIAL SOLID WASTE FOR 1989

SIC 1980 Code	SECTOR NAME	PLASTIC Tonne/M$RDP	ORGANICS Tonne/M$RDP	METALS Tonne/M$RDP	TIRES Tonne/M$RDP	OTHER Tonne/M$RDP	TOTAL Tonne/M$RDP
	MANUFACTURING						
--	Manufacturing - Total	--	--	--	--	--	--
101-114	Food Production Including Beverages	2.6221	41.7833	6.8390	--	17.1673	107.0376
102	Food Production - Fish	--	--	--	--	--	--
101,103-109	Food Prod. - Other than Fish	--	--	--	--	--	--
111-114	Beverages	--	--	--	--	--	--
121-122	Tobacco	--	--	--	--	--	--
151-159	Rubber	--	--	--	--	--	--
161-169	Plastic	--	--	--	--	--	--
171	Leather	--	--	--	--	--	--
151-171	Rubber/Plastic/Leather	13.6924	--	4.1987	8.9641	10.4277	210.5036
181-249	Textiles, Textile Products, Clothing	3.2313	--	0.4676	--	25.2325	37.4473
243-249	Garments and Clothing	--	--	--	--	--	--
251-259	Wood	2.0608	--	0.5460	--	8.4908	38.9703
261-269	Furniture	--	--	6.7223	--	79.8313	127.5604
271-279	Paper & Allied- Total	0.0812	2.9016	8.7356	--	2.8518	44.9837
271	Paper & Allied- Pulp & Paper	--	--	--	--	--	--
272-279	Paper & Allied- Paper Conv	--	--	--	--	--	--
281-284	Printing & Publishing	0.0319	--	0.0361	--	1.5897	20.0423
291-298	Primary Metal - Total	--	--	0.5180	--	7.5166	35.9681
291-294	Primary Metal - Iron and Steel	--	--	--	--	--	--
295-298	Primary Metal - Non-Ferrous	--	--	--	--	--	--
301-309	Metal Fabrication - Total	0.5260	0.0109	23.9900	--	11.1140	54.2146
311-319	Machinery (Excl. Electrical) - Total	0.9320	0.3644	6.2714	--	13.5562	28.9468
321-329	Transportation Equipment - Total	0.0189	0.0379	12.6276	--	22.1787	47.3296
323	Transportation Equip. - Motor Vehicle	--	--	--	--	--	--
321	Transportation Equip. - Aircraft etc.	--	--	--	--	--	--
326,329	Railroad Rolling Stock & Misc.	--	--	--	--	--	--
327-328	Transportation Equip. - Shipbuilding	--	--	--	--	--	--
331-339	Electrical Equipment - Total	0.5357	--	0.9671	--	0.1889	16.2822
351-359	Non-Metallic Mineral - Total	0.0082	--	26.6959	--	10.3506	42.2475
351,354-355	Non-Metallic Cement & Clay Production	--	--	--	--	--	--
356	Non-Metallic - Glass	--	--	--	--	--	--

Economy - Environment Linkages

INDUSTRIAL SOLID WASTE FOR 1989

SIC 1980 Code	SECTOR NAME	PLASTIC	ORGANICS	METALS	TIRES	OTHER	TOTAL
		Tonne/M$RDP	Tonne/M$RDP	Tonne/M$RDP	Tonne/M$RDP	Tonne/M$RDP	Tonne/M$RDP
361-369	Petroleum & Coal- Total	--	--	--	--	--	--
371-379	Chemicals - Total	1.8954	0.0170	1.0693	--	4.4126	42.9385
371	Chemicals - Industrial	--	--	--	--	--	--
372-379	Chemicals - Non-Industrial	--	--	--	--	--	--
391-399	Manufacturing - Other Misc.	0.2245	--	5.6679	--	5.3379	36.0409

Appendix 2

Background on the Econometric Models and Simulations

APPENDIX 2
BACKGROUND ON THE ECONOMETRIC MODELS AND SIMULATIONS

This appendix provides a brief overview of the models used to create the scenarios and a description of the methodology used to include specific assumptions about industrial structure and technology.

Two econometric models have been used to produce all scenarios, and incorporate the assumption of environmental action. The Informetrica Model (TIM) represents the national, Canadian economy; the Regional-Industrial Model (RIM) allocates the national results to each of the provinces, and the two territories. The following section provides basic descriptions of each of these models.

A2.1 Overview of Model Structures

A2.1.1 TIM Description

The Informetrica Model (TIM) is a large, disaggregated econometric model of the Canadian economy. The basic structure of the model follows in the tradition of several predecessor models including those of the CANDIDE family and earlier ones such as the Klein-Goldberger and Brookings models. A highly simultaneous model, TIM provides forecasts for almost 10,000 variables in four broad economic super-sectors: Final Demand, Industry Activity and Income, Sector Incomes, and the Supply Side. The key feature of TIM is the highly disaggregated final demand section. Individual estimates are available for:

- 64 categories of consumer expenditure;
- government expenditures by function, type and level;
- 75 export categories with separate equations for the U.S. and rest-of-world;
- 83 import categories with the same directional detail;
- separate estimates for each of plant and equipment investment and capital stocks for over 60 industrial categories; and
- projections for residential construction.

This level of detail was made possible by the National Accounts improvements and revisions which took place between 1986 and 1988.

The final demand sector is an important channel for the resolution of impacts and for the differentiation of alternatives. Most final demand categories are explained as functions of relative prices and incomes. Thus, any factor that affects either prices or incomes will directly change the level and/or composition of final demand. One characteristic of TIM is an endogenous government expenditure section with "reaction functions" providing a linkage from the scale and composition of the economy or government revenues and/or activities, back to government expenditure on goods and services. In some policy impacts, these reaction functions are specifically exogenized to exclude an additional government response. The disaggregated specification of TIM's final demand section makes possible detailed forecasts and impact analysis unique to Informetrica.

An input-output system translates final demand into activity (constant-dollar GDP at factor cost) for 112 industries. Estimates of employment and capital stock are used to develop a complete set of the components of factor incomes by industry. These are combined with taxes, subsidies and import prices to provide estimates of the cost of production. In turn, these domestic cost measures are combined with import prices to provide the final demand prices. Thus, any change in domestic incomes, unit labour costs or foreign prices is passed to domestic prices through the prices model. This input-output system at the core of TIM makes industrial analysis possible. This analysis is not usually associated with macro-forecasting, but necessary for business analysis and policy formulation.

The "Business vs. Non-Business" distinction in the National Accounts industrial data is incorporated in TIM. Total income is allocated to the four major economic groups or sectors (persons and unincorporated business, governments, corporations and the foreign sector) consistent with factor incomes from production, foreign income flows, investment income by sector and government taxation and transfer programs. These incomes and the final demand prices are the major explanatory variables in the determination of final demand. Thus, one channel for the resolution of an impact is either directly or indirectly through the sector incomes and hence to final demand.

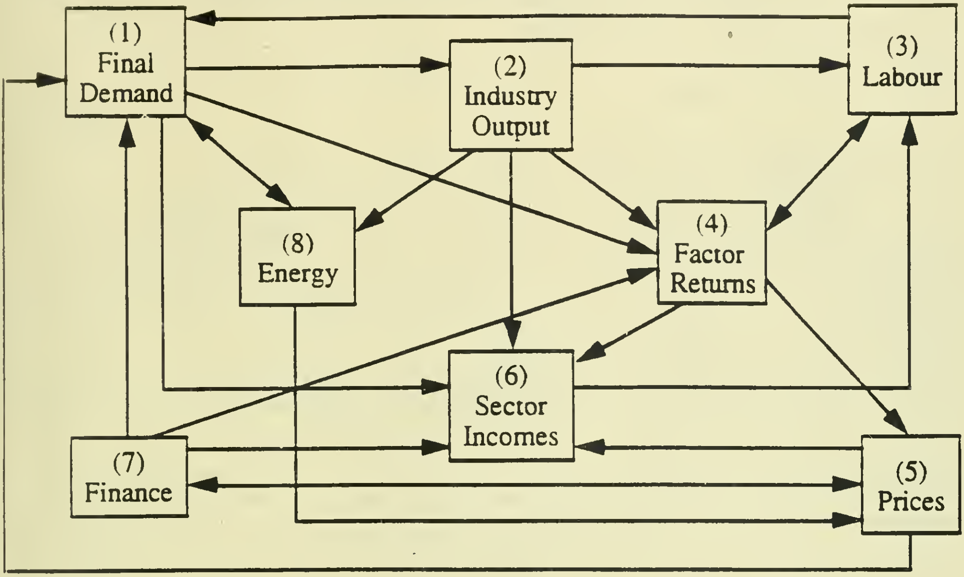
The estimates of output and the corresponding capital stocks are the key explanatory variables in the production functions which provide consistent estimates of labour demand by industry. Thus, an impact, which initially affected investment, would also be expected to impact labour demand. Estimates of labour demand are provided for 62 industries. For some industries, the estimates are developed in a two-step, non-linear process to reflect the appropriate adjustment from short-term influences towards the longer-term labour requirements.

The level of factor demands, as defined by capital stock, employment and output as well as prices and interest rates, is key to the derivation of nominal industrial income (GDP) disaggregated by industry in terms of wages, unincorporated income and surplus or return to capital.

On the "supply-side", a demographic model provides endogenous labour supply and education demand estimates, and investment and discard series provide corresponding capital stock measures.

The Informetrica Model

Sectoral Structure



(1) Consumption = *f* (real personal income, relative prices, demographics)
Investment = *f* (capital stock, output, industry income, capital prices)
Government = *f* (activity)
Imports = *f* (activity, relative prices, tariff rate changes)
Exports = *f* (foreign activity, relative prices)

(2) Output = *f* (Consumption + Investment + Government + Exports - Imports)

(3) Labour Supply = *f* (income, demographics, labour market tightness)
Employment = *f* (output, capital stock)

(4) Labour Income = *f* (labour market tightness, output, capital stock, prices)
Capital Income = *f* (interest rates, capital costs and stock, foreign prices, subsidies)
Other Business Income = *f* (output, prices)

(5) Prices = *f* (foreign prices, domestic factor incomes, taxes and subsidies)

(6) Personal Income = *f* (labour income, transfers, property income)
Corporate Income = *f* (domestic and foreign capital income)
Government Income = *f* (net interest, tax revenue)
Foreign Income = *f* (personal remittances, earnings on investment)

(7) Interest Rates = *f* (foreign interest rates, relative inflation)

(8) Oil Production = *f* (exogenous assumptions)
Oil Demand = *f* (industry, household, and foreign demand)
Gas Production: Net Requirement. Gas Demand = *f* (industry, household, and foreign demand)
Energy Prices = *f* (oil prices, tax and subsidy assumptions)

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Informetrica plans to develop a sophisticated energy model to incorporate in TIM. For the time being, domestic demand for oil, gas, electricity and coal are forecast endogenously. Energy production (by province) and prices are exogenous, and either exports or imports (depending on the energy commodity) are defined residually.

A2.1.2 RIM Description

The Regional-Industrial Model (RIM), a formal "top-down" model, is used to provide the provincial dimension to the estimates of industrial activity, employment and income. Because of the availability of the sophisticated macroeconomic structure inherent in The Informetrica Model (TIM), the structure of RIM is focused directly on the regionalization of the detailed outputs from TIM. The major model flows are outlined in the RIM Flow Chart.

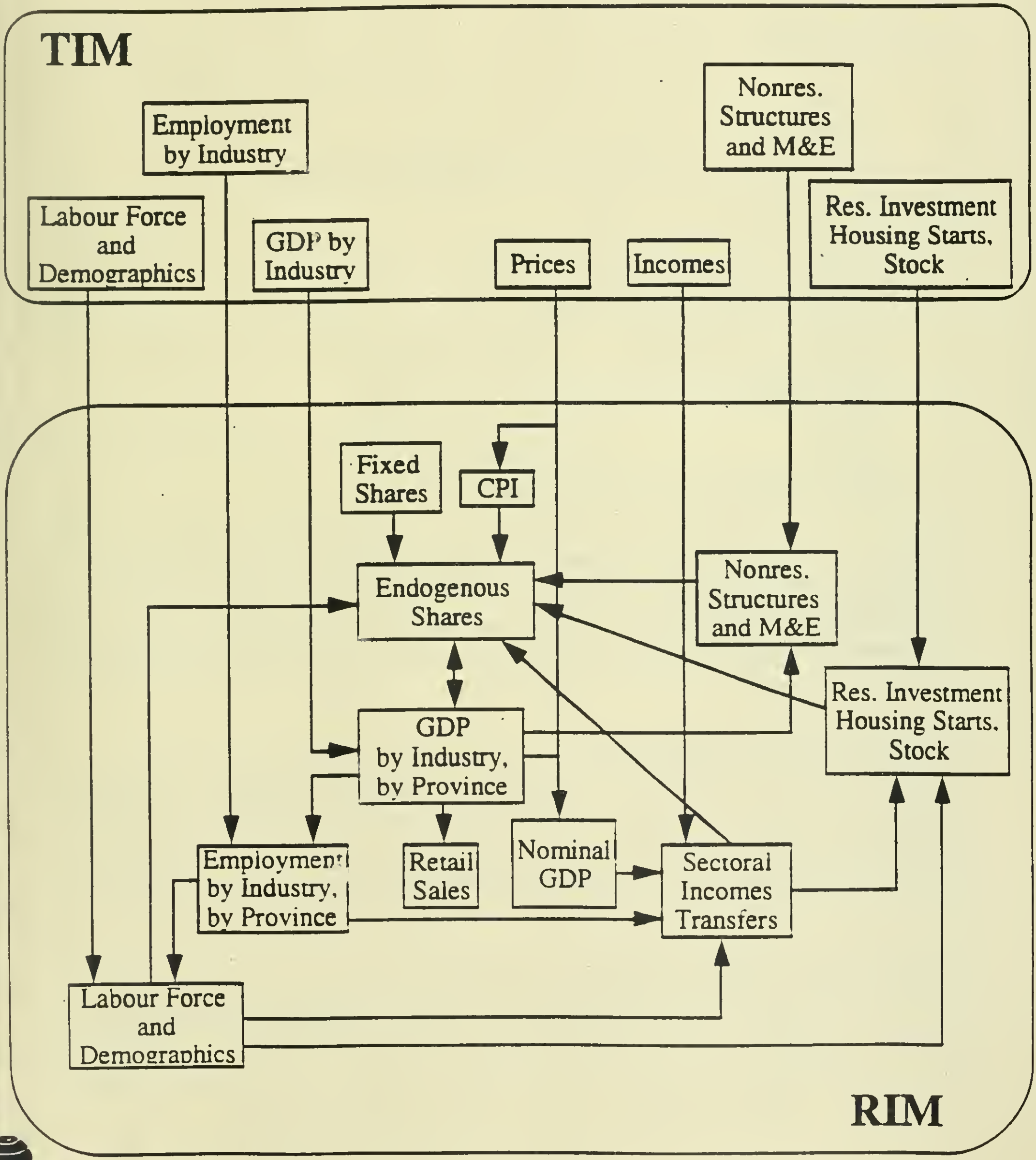
The initial stage is the regionalization of the TIM forecasts for industrial output--Gross Domestic Product at constant prices--for 61 industries. In general, for these impacts, the regional shares of activity for most traded goods-producing industries are unchanged from their base case values. The major exceptions to this rule are primary sector industries, such as metal mining, whose shares have been altered because of detailed final demand responses in TIM. For example, the focus in B.C. is on copper, whereas the dominant metal in Ontario is nickel. In these impacts, the relative export responses of the various metal categories in TIM is used to vary the regional shares of metal mining. For example, the variation in fertilizer exports, (e.g., potash), is the major determinant for Saskatchewan's share of non-metallic mineral output but does not directly affect the level of non-metallic mineral output in Ontario.

The assumption of stability of regional shares for other goods-producing industries, particularly manufacturing, is tenable because of the level of industrial disaggregation in RIM. For example, the differential impact of a change in interest rates on the demand for ships relative to the demand for automobiles is easily regionalized because both components of transportation equipment manufacturing are considered separately within the TIM/RIM framework.

The principal determinant of regional construction activity is, of course, residential and nonresidential investment. The national investment forecasts at the detailed industrial level are distributed to the regions using the regional estimates of constant dollar GDP as the principal explanatory variables. Estimates are provided for 14 industrial sectors for investment, discards and capital stock for both nonresidential structures and for machinery and equipment. The regional forecasts of housing starts are primarily a function of regional income, the vacancy rate and the housing stock. Estimates are provided for starts, completions and stocks for both singles and multiples for the 10 provinces.

The regional allocation of activity in the non-traded goods and services industries is determined by the regional level of households, aggregate income, GDP or some similar measure relative

Regional-Industrial Model


TIM
Employment by Industry
Labour Force and Demographics
GDP by Industry
Prices
Incomes
Nonres. Structures and M&E
Res. Investment Housing Starts, Stock
Fixed Shares
CPI
Endogenous Shares
Nonres. Structures and M&E
GDP by Industry, by Province
Res. Investment Housing Starts, Stock
Employment by Industry, by Province
Retail Sales
Nominal GDP
Sectoral Incomes Transfers
Labour Force and Demographics
RIM

Informetrica Limited

to the corresponding national level. For some industries, such as wholesale trade, some cross-region relationships are modelled.

The level of industrial detail in RIM reflects the uniqueness of the databases created by Informetrica to support its model development. RIM's industrial detail includes:

- Agriculture;
- Forestry;
- Fishing;
- Resource Extraction (Mining) and 6 sub-industries;
- Manufacturing, 19 major groups and 6 transportation-equipment sub-industries;
- Construction;
- Transportation Services and 7 sub-industries;
- Storage;
- Communications and 3 sub-industries;
- Utilities and 3 sub-industries;
- Commercial and Public Services and 6 sub-industries;
- Finance, Insurance and Real Estate;
- Royalties;
- Imputed Income from Owner-Occupied Dwellings; and
- Public Administration and 3 sub-industries.

Employment for 61 industries in each province is determined by relative regional productivity, national labour/output ratios and by the level of industrial output in each region. The provincial share of households is determined in the model principally as a function of that region's current and past employment share. The size of the provincial labour force is determined by the level of households or employment and the regional distribution of income.

Labour income is allocated using national income/output ratios and the regional distribution of industrial output. Nominal Gross Domestic Product is allocated provincially using national value-added prices and regional industrial output. Personal income in each province is the sum of labour income, unincorporated income and transfers from other sectors. Of the latter, UI benefits are regionalized using the relevant unemployment levels and rates. Other transfers are regionalized principally by the distribution of households or of income.

When comparing the national and regional results, it should be noted that only domestic concepts are used within the regional model. Therefore, the measure of corporate profits used excludes the impact of net foreign income flows. Similarly, the impact of a shock on Gross Domestic Product is not equivalent to that on Gross National Product because of these same flows, as well as because of the difference between a factor cost and a market price measure. Finally, the concept of labour income used in the regional model excludes military pay and allowances. However, these are included in personal income.

A2.2 Incorporating Environmental Initiatives in Economic Scenarios

In Scenario 3, reviewed in Chapter 3, we have assumed that new, wide-ranging environmental initiatives affect the Canadian and Ontario economies over the coming two decades. This section reviews general issues involved in simulating these initiatives and the specific manner in which changes were made to create Scenario 3.

A2.2.1 Generic Description of Research Task

Although they are not explicitly identified within the model structures, all of the economic scenarios reported in this study implicitly assume that emissions, discards and other sources of environmental stress are occurring. Similarly, all scenarios assume that households, business and governments, in their investment spending, and in their operating costs, are allocating sums to eliminate, reduce or otherwise mitigate such stress.

Environmental Action as an Exogenous Economic Event

Such action may take several forms, including spending to add "end-of-pipe" environmental capital on to plant and equipment that is otherwise applied to produce goods and services needed to meet domestic and foreign demands. It may also include the application of "sustainable development" capital, which has begun to be identified with design of equipment that incorporates environmental considerations. Whether such capital constitutes a net addition to real investment costs, or leads to changes in aggregate operating costs, needs to be defined on a case-by-case basis.

Seen in this form, action bears directly on specific sectors and industries. Action may also suggest altered spending responsibilities among sectors. For example, initiatives aimed at reducing most air emissions may suggest a move to urban, high-speed transit, and more energy-efficient forms of inter-urban transportation. To reflect this, investment and operating expenses for transportation should be increased, and transportation spending by households, businesses and government should be decreased. Similarly, initiatives aimed at reducing at-source emissions into water streams imply additional requirements for investment and operating expenditures by emitting industries, households and government. For municipalities, who are otherwise principally responsible for operating water and sewage systems, spending might well be reduced. Similar reallocations are implied by initiatives focused on non-toxic waste.

Summarizing, environmental "initiatives" may directly affect the economy, as these are seen in an economic modelling framework, in several forms:

- as changes to investment activity of business producers, households in their spending for residences, and governments;
- as changes to the mix of demands on producers who supply such real fixed capital; and
- as changes to operating expenditures, where these would include exogenous changes to employment, and either the level, and/or mix of material requirements needed to produce a unit of gross output (i.e., shipments).

Even highly detailed economic models typically take as given the structured relationship between investment demands and suppliers, material supply relationships between producing industries, and relationships between output, capital stock and employment. Models do not "endogenously" incorporate information about technological options, or the behavioral bases for choosing among those options. Rather exogenous changes are imposed from detailed studies of environmental initiatives on the structure and operation of the model.

Transmission of Environmental Action Through the Economy

Given assumptions about these direct impacts on the economy, models then assess the indirect and induced implications for the economy as a whole, and the implications of this for specific producing and consuming sectors. Thus, an investment of $100 million in equipment and process changes to reduce emissions of the pulp and paper industry will directly require resources from the construction industry, and in turn, indirectly from all of the producers of construction materials (and their suppliers) and the equipment that may be installed. Additions to employment needed to supply such goods will yield added labour income, which through spending of households, will induce additional consumption, and its supply. Through corporate and government incomes, similar induced effects should follow in the form of additional investment, and government spending or debt reduction. Arguably, changes to interest rates may follow setting off yet more induced effects.

Depending on the nature of the model used, another important set of transmission mechanisms may also be evaluated. In the long run, additions to real resources needed to reduce environmental stress, whether in the form of additional capital or operating expenditures, represent additional real costs to the economy that bear differentially on various producer and income sectors. Depending on the nature of specific producer commodity and factor markets, this will be reflected in changes to prices of goods and services, or employment, or business incomes and investment. Such changes in relative prices then alter demand and supply through varying price sensitivities of domestic and foreign "consumers" of commodities. Overall price impacts are the weighted sum of producer and import prices, and changes to final demand taxes and subsidies. If the instrument used to cause the initiative is an indirect tax or subsidy imposed at the producer level, this will also be reflected in prices faced by foreign and domestic purchasers.

True sustainable benefits to the economy can also be introduced. Positive effects in the form of improved quality or enlarged supply of agricultural product, fish, and trees and their products can be imposed as productivity gains. Benefits in the form of reduced stress on the stock of structures can be introduced as reduced investment requirements or scrappage rates. Benefits to human health can be variously introduced into the population model through changes to death rates and requirements for public and private expenditures in the health system. Changes in responsibility for action are represented by action simulating reduced emissions to the water systems by households and businesses, or increased private responsibility for packaging can be reflected in reduced, generally public, expenditures. The implications of this feature of action were not included in the study, however.

A2.2.2 Model Changes for Scenario 3

Basis for Assumed Environmental Action

In Scenario 3, environmental initiatives have been added to the Productivity scenario, which constitutes the "base case".

The inputs to the model that represent the initiatives draw on work of Informetrica, undertaken since 1988. This has focused on the investment and operating cost changes associated with various environmental initiatives (e.g., reduction of CO_2 emissions, emissions associated with Acid Rain, NO_X/VOC and other Regulation 308 types of emissions, and several initiatives related to reduction of emissions into water streams, or spending implications for municipalities of more strict standards related to water). Such direct expenditure changes have all implied net additions to investment (and therefore, to the size of the public and private stock of capital), and employment increases, as a reflection of added operating expenses. These assumptions were carefully reviewed, and often modified, by Ministry of Environment and other-team members.

In particular, the estimates of expected environmental investments in Scenario 3 began with the 1990 federal "Green Plan".[1] Informetrica, in a 1991 paper, had created estimates of capital spending that would be associated with the plan and these numbers were used as a starting point.[2] These investment estimates were adjusted to reflect research on various aspects of environmental plans done since the publication of the Green Plan. The Ministry of the

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[1] See "Canada's Green Plan", Supply and Services Ottawa, 1990

[2] See "Environment-Economy Linkages, A Quantitative Analysis of the Federal Green Plan and Policy Implications" Carl Sonnen, Informetrica Ltd., presented to the CABE/CEA Joint Session on Resources and Sustainable Development, Kingston, 1991.

Environment provided estimates from Countdown Acid Rain (capital spending by Inco and Falconbridge and Ontario Hydro), NOX/VOC emissions from a 1992 study, MISA estimates of capital spending needed by industrial sectors, Waste Reduction Action Plan (WRAP) estimates for solid waste and data on the implementation costs, for the Remedial Action Plan for stormwater, agricultural non-point source waste and restoration work. Estimates were also included for the Ontario Hydro Conservation Plan and the Toronto Transit Commission's Let's Move initiative. Various estimates for waste reduction from the National Packaging Protocol were considered, but in the final version this initiative was dropped.[3]

In addition to the estimates of capital costs for implementing the environmental initiatives, these studies also provided information about operating costs and emission reductions. The former were used in the model simulations in Scenario 3 and the latter were incorporated into reduced environmental factors and related emissions in Chapter 5.

Notable Features of the Assumptions

Several special features regarding these assumptions should be noted.

- The models used in this study are highly detailed in both producer and demand terms (see A2.1). Accordingly, additional investment and employment requirements have been imposed on the models for each of the more than 100 industries that are separately identified. This feature is important to an assessment of relative-price effects on sectors and the economy as a whole.

  Given this, effects on "structure" are sensitive to the extent to which action bears more or less than proportionately on specific sectors.

- There remains a large amount of uncertainty about the size of the "environmental stress gap" that needs to be closed, and the action that is consequently required. A related problem is uncertainty about the extent to which future investment and capital stock in the base case is less emission intensive than the current capital stock. Most of the detailed studies from which this work is drawn have focused on altering the current stock of capital and processes. We have assumed that these amounts needed to bring the current stock of capital up to some new desired standard occurs over several years into the future.

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[3] See "Nitrogen Oxide and Volatile Organic Compounds Abatement Cost Study" Ontario Ministry of Environment, March 1992. "MISA Water Pollution Abatement Technology and Cost Study", Ministry of the Environment, May 1991 and other Ministry sources.

What about the capital stock that will be added to the economy over the future? Spreading our assumed amounts, as the total required, over the course of the next ten to twenty years implicitly assumes that investment added from now, in the base case, is no more emission intensive than the targeted new standard. This is almost certainly unlikely to be true, since investments made in 1992 and 1993, for example, will likely include some "old" technology, some, which is less emission intensive than investments made ten years ago but still below the "new" standards, and some which meets the "new" standards. Accordingly, the assumptions used in the study probably understate the real resource requirements needed to achieve a given level of stress reduction. As, however, we have no way of knowing what the mix of base case investment will be over the next two decades, we cannot quantify this.

- For any environmental initiative, there is even greater uncertainty about which of many technical options may be used to close such gaps. Studies that carefully review what needs to be done consider technical options but do not typically specify in detail which of these may be chosen. Although our research approach enables us to alter the "menu" of demands on producing sectors that satisfy the requirements of a specific investment, and enables us to reallocate material requirements associated with the production of industrial gross output that may be affected by process changes, the specifics of these two changes are not readily available and have not been incorporated into this study.

We have, however, allocated, a larger-than-normal proportion of investment to spending on machinery and equipment, as opposed to spending on structures, in those cases where the initiative suggested this. Given the standard "menu" of requirements that are defined by our input-output tables in the model structure, this then concentrates production effects in electrical and non-electrical machinery, and a variety of other manufacturing industries. In turn, there are indirect effects on all industries, and standard relationships between domestic and foreign supply are determined by the import equations of the model.

Arguably, some of the initiatives may demand production that is quite distinct from the standard menu that links investment demand of an industry and the production that responds to this. Even at the fairly high level of disaggregation at which the model is defined, however, these distinctions are not likely to be major; effectively, one type of electrical or non-electrical machinery is likely to be replaced by another. Detailed studies we have undertaken suggest that for "high tech" solutions, the model's import equations would understate the extent to which imports are affected, and overstate the positive effects on domestic suppliers.

Similarly, some initiatives may well alter the mix of material requirements needed to produce goods and services in industries that are directly affected by environmental initiatives. Initiatives aimed at reducing furan and dioxin emissions, for example, would reduce demands on industrial chemicals. Many of the initiatives aimed at reducing air emissions imply a reduction in the use of energy (coal, oil and natural gas, and their manufactured products). The extent to which this would occur in each case is not well defined, especially at the industry level. Further, it is not readily apparent whether such reductions in demand occur at the expense of domestic or foreign production. We have characteristically reflected this effect through reductions in consumer demand and through changes to several import categories to force such consumer effects onto domestic producers.

It may well be true that our results understate the negative effects on energy producers, and their suppliers. It is also important to note, as is indicated by the furan and dioxin case, that both positive and negative effects on a wide range of other producers associated with non-energy initiatives would occur, and they also are not reflected in our results.

- Posited changes to each industry's production function (the relationship between output, employment and capital stock) have two model-specific implications. Additions to investment associated with environmental initiatives increase the size of the capital stock available to each industry identified in the models. Endogenously, such an increase would alter the relationship between output and employment, in many cases reducing the latter per unit of output. We have assumed that information drawn from detailed studies, which suggests increases in operating costs, is an ex post view. Accordingly, (1) we have compensated for the endogenous impacts on employment (i.e., have neutralized the labour-savings effects of added investment) and (2) through constant-adjustment procedures have treated the labour component of additional operating expenditures as additive to the activity that would otherwise occur.

- For the most part, direct impacts on investment and employment have been introduced through constant adjustment procedures. (To any behavioral, or "stochastic", equation in the model that is directly affected by an environmental action, we have added the "amount" of that action to the "intercept" term in the equation.) The significance of this lies in the fact that industries that are directly affected by action reflect this, but are otherwise endogenously sensitive to other actions in the economy. This presumes that normal "behaviour", which is captured in the equation, is otherwise applicable. Thus, producers of refined petroleum products will, measured in terms of output, face the unfavourable consequences of increased product prices that follows from their requirement to use more real resources (costs), and they will be faced with the unfavourable consequences that follow from reduced consumer and industrial requirements for energy (efficiency gains). On the other hand, increased levels of activity for those supplying investment goods, or operating goods and services, will generate a positive effect.

- Just as technical detail about solutions is uncertain, so too are decisions about what public policy instruments "cause" initiatives. Tax or other systems that bear directly on prices are one choice; command and control regulations that set standards to be achieved are another. In the former case, price effects should lead to pure conservation effects among consumers, but they are a "blunt" signal to the model with respect to the amount of investment and process change that is needed to achieve effects in the production system. Given data limitations and conceptual difficulties, investment equations (and the capital stock) do not separately identify "environmental" from market-measured "productive" capital. Thus, a "carbon tax" would not customarily "cause" (in the model) an industry to take investment action to achieve an energy efficiency gain.

  As this study focuses principally on changes to the structure of production, we have introduced initiatives in a form that emphasizes this aspect of required change, and incorporates such technical information as is readily available. It may be tempting to think of this as a "command and control" assumption, but it may well be true that the effect on the price system, including relative price changes at the producer level, would be the same regardless of the instrument chosen. Additions to real resources required of producers must, in the long run, be financed through prices, which may cause reduced activity and future investment.

Environmental Action and Consequences in TIM

Introduction of initiatives as investment activity of households, governments and businesses (detailed for the 112 industries identified in the national model) occurs in the "Final Demand" blocks of the model - see the accompanying schematic "The Informetrica Model: Sectoral Structure". Introduction of operating-expenditure implications for employment are introduced directly into the labour requirement model blocks (3). For businesses, these ex ante changes to factor requirements lead endogenously to changes in factor incomes (4), and through this mechanism, net of changes to productivity, yield changes to producer and final demand prices(5). As these are principal terms affecting real final demand, price effects on consumers, and "competitiveness" considerations are endogenously determined. For expenditures made by governments, we have assumed that "fees" are raised sufficient to cover additions to annualized expenses of the governments concerned (principally, municipal governments).

Incomes of households, businesses and governments (and foreigners) are determined net of direct, indirect and induced effects. We have assumed there are no implications for the exchange rate or interest rates, partly to isolate the structural implications of the scenario. Effects here, as well as in the foreign trade blocks, would be highly sensitive to assumptions about whether the initiatives are taken unilaterally by Canada, or in combination with other national jurisdictions. We have assumed that the initiatives are a unilateral Canadian action.

Environmental Action and Consequences in RIM

Allocation of the national effects to provinces has been generated through the Regional-Industrial Model, for which an accompanying schematic is also provided. Where there are direct implications for investment in structures, we have allocated impacts on construction activity and employment proportionate to the provincial distribution of such direct effects. That is, we presume that action that directly affects the construction sector of a province is locally supplied. We have, however, assumed that demands on manufacturers to supply requirements for machinery and equipment are determined by the base case distribution of manufacturing capacity. That is, for reasons cited below, we have assumed that direct impacts on manufacturers are based on normal market considerations, which as often as not, tend not to be "local".

Implicitly, we have assumed there are no special effects on the distribution of provincial activity that might follow from application of "industrial strategies" developed to support local supply of manufactures, or services. To do so would require the ex ante introduction of changes to investment in the supplying industries, for example, capital assistance or government training funding. Further, it is not immediately clear that such supply-side initiatives would particularly affect our main distribution rule for manufactures since these markets are highly competitive and face few inter-provincial trade barriers. Also, initiatives that required "local procurement" might well "force" procurement of the environmental equipment to local sources, but their indirect requirements would presumably be determined by normal market considerations, and for those who are operating at capacity, this would simply "crowd out" other sources of demand, forcing them to source their requirements in other provinces. Finally, to have introduced special local procurement provisions would raise a number of public policy issues that can be characterized as "beggar my neighbour" problems. Since the case used in this study is a national action scenario, our assumptions generate disproportionately strong activity effects for Ontario and Quebec, where much of manufacturing is located.

Given this, and national results, the Regional-Industrial Model determines provincial impacts as follows, with reference to the RIM schematic. TIM-estimated changes to industry GDP and employment, and to estimates of nonresidential and residential investment represent changes to national amounts. To "direct" construction activity to the appropriate province, RIM estimates of "nonresidential structures" and "residential investment" are modified to reflect the pattern of provincial expenditures that represent our estimates of environmental action.

Activity in most goods-producing industries is allocated on the basis of fixed shares of national activity. For construction, and manufacturing and mining of construction materials, these are modified to reflect the assumed provincial patterns of expenditures. Services in each province are endogenous to activity in the fixed-share industries of the province, or those that are proximate. Industry employment in each province, is derived given provincially fixed output-labour ratios at the industry level.

For each province, labour supply, and population, are sensitive to relative employment opportunities in each province. In turn, these population effects induce further activity in the services industries of each province. For example, as a principal supplier of the country's manufactured goods, Ontario would benefit from the investment-related spending of the assumed environmental initiatives. As this adds to the relative employment opportunities of the province, additional labour supply is drawn (net) from other provinces, reinforcing the aggregate output, employment and income benefits to the province that follow directly from the requirement for more manufactures. Provincial incomes are determined by labour income of the province, and transfers. In this study, transfer incomes are not altered.